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TO ADVERTISERS
CHANGES for advertisements should be in this office by Friday noon for the following week's issue.
NEW ADVERTISEMENTS should be in the office not later than Monday noon to ensure publication in that week's issue.

This number of the ELECTRICAL REVIEW celebrates its twentieth anniversary. The contents have been chosen with reference particularly to showing the contrasts between to-day and twenty years ago and the advance that has been made in all directions in the electrical field since then.

In the following pages will be found a collection of illustrations which are perhaps unique in their way, and the reproduction of engravings contemporary with some of the earliest applications of the art. A number of portraits of men prominent in one direction or another in the development of the electrical arts and trades is also shown.

The ELECTRICAL REVIEW seizes the occasion of its birthday party to thank its numerous friends who have kindly contributed the interesting retrospective articles which are to be found in the following pages, and also to express its appreciation of its many highly esteemed patrons.

TWENTY YEARS OF ELECTRICAL DEVELOPMENT.

It would have been a bold and daring prophet who might have hazarded, twenty years ago, a statement of his belief that one-half of what has been accomplished since then in electrical development would be possible. Nothing goes further to prove the wisdom of the ancient saying that the truth is stranger than fiction than the development of the various industrial and engineering arts that have grown up in the last century around the discovery of Volta, and in the last twenty years through the commercial expansion of electrical applications.

In 1882 the arc light had come into some degree of use for the illumination of streets; the incandescent light was still a novelty; the telephone was in limited use in the larger cities; the trolley car was practically undreamed of; the electric motor was a curiosity, and electrolytic chemistry was known only in the laboratories of a few advanced chemists. In twenty years the railway and the telephone have combined to alter methods of business and to work an improvement in the conditions of municipal progress that would have been thought an impossible perfection by the most ardent reformer in the early days.

In 1882 the telegraph was by far the largest commercial application of electricity. In the United States alone it has practically doubled in extent and importance since then, and in the world to-day the telegraph investment approaches the enormous sum of five hundred million dollars. Thousands upon thousands of people are employed for its operation and in the industries which are maintained to furnish its material.

From the small beginnings of twenty years ago the telephone has grown, until now one company in the United States alone handles five million calls a day and operates enough miles of copper wire to stretch six circuits between the earth and the moon. In the last few years there has been a tremendous acceleration in the growth of the telephone and one can foresee the not far distant day when practically every respectable habitation and place of business will be connected to every other through its agency. The telephone is destined to become as common as the door-bell.

To-day the electric light is practically universal. It is found everywhere and is used for all purposes to which artificial light may be put, and for many for which no other illuminant would be possible. In the city of New York more power is used for its generation than is required aboard all the ships of the United States Navy. The investment of money in the electric lighting industry is colossal, and the income derived from it in the United States alone is equal to the revenues of a second-class empire. To supply the demands of this industry, lamp factories, carbon works, engine and dynamo building establishments, wire mills and many other industries giving remunerative employment to thousands of operatives, have sprung into existence within the last two decades.

In the year of the birth of the ELECTRICAL REVIEW—1882—the first experiments in electric traction were made by Mr. Edison at Menlo Park. Five years later Mr. Sprague built the Richmond road of historic memory. In the fifteen years following that date the trolley track has covered the United States with an expanding network and has wrought a silent but far-reaching revolution in the conditions of living. By distributing the crowded populations of cities it has become one of the most important factors for bettering the general social condition. It has removed thousands of horses from city streets, thereby immediately bettering the health of municipalities. The money spent in building electric railroads in the United States has already aggregated a sum equal to the cost of the Civil War. The power

employed in driving electric street cars reaches the enormous total of half a million horse-power. If this power were concentrated in an electric arc it would doubtless be visible with ease to the inhabitants of Mars. The number of passengers transported by the trolley in this country in a month is greater than the population of China, and in a year exceeds by several times the population of the earth.

The progress of electrochemistry and metallurgy in the last decade has been marvelous. The greater part of the American output of copper is now refined by electrical processes. Caustic soda and bleaching powder, chemicals of great value in the important arts of soap making, paper making and textile manufacturing, have been greatly reduced in cost by electrical processes. In 1882 aluminum was a curiosity among the precious metals. To-day it is a rival of the cheapest brass and, saving only iron and zinc, is the least costly of metals.

The minor applications of electricity are seen to-day on every hand. The electric fan, the innumerable push-buttons, bells and annunciators of our houses and hotels, testify the popularity of electrical apparatus. Electrical heating and cooking are commercial successes and are rapidly growing in favor.

The remotest corners of the earth are connected by the telegraph. Within another year work will have begun on the last link of the electric girdle of the earth —the Pacific cable. No less than sixteen working cables cross the Atlantic Ocean to-day.

In a shorter time than has marked the growth of any other important industry in the history of the world the electrical arts have leapt from insignificance to the highest rank of importance. The daily life of every citizen touches on all sides the results of the marvelous progress already accomplished. The dependence of the world on electricity is such that one day's stoppage of the operating electrical installations in it would result in universal panic and disaster. Fifteen years ago electricity began the emancipation of the horse as a beast of burden. To-day it is accomplishing the emancipation of the human race from the trammels of outgrown social conditions and the necessities of hard and unproductive manual labor.

ELECTRICAL INSTRUCTION.

One of the symptoms indicating the widespread interest in electrical matters in this country is the fact that practically every college, as certainly every technical school, has a department of electrical instruction. It is very interesting to examine the courses of instruction presented, to compare with one another, and especially to note the differing aims which seem to underlie the methods of teaching employed.

There is no doubt that we are going at present through a period of somewhat hesitating uncertainty regarding the best method of giving instruction in electrical engineering. The result attained in most of the schools is by no means all that could be desired, while some of them do produce graduates who are at least competent to begin the real work of learning their subject.

It may fairly be said that in nearly all cases the mistake is made of attempting to train electrical engineers in school. The very definition of an engineer shows the futility of such an attempt. An engineer may be thought of as one competent to direct works which shall successfully produce the largest result for the least expenditure of materials, labor, time and money. Probably no better definition than this can be given to-day of the multitudinous duties of engineers in general and of electrical engineers in particular. The consequence is that with a subject of such widespread extent as electricity it is practically impossible, within the time limit of a college course, to give the student the advantages both of a thorough knowledge of all its details and of a methodical arrangement of mind, which will enable him to grasp situations as they arise and to overcome the obstacles which will present themselves in his path. The best instruction certainly is that which teaches the student how to learn, the training that gives him the method of his craft, the teaching that shows him how to think and to appreciate what he sees, the instruction that gives him the fundamentals and does not burden him with the details; these are the things that are of avail and use to him in his career. But no young man can come out of the college or the technical school a competent engineer. It is beginning to be recognized, as it should always have been, that there must intervene a period of learning, not less difficult and not less important than that spent in academical surroundings, before the man is actually competent to take his place alongside of other workers in his chosen field.

Any one who is in the least familiar with the complexity, the magnitude and the variety of electrical work to-day will see at once that it is far beyond the resources of any university or school to maintain laboratories which shall be typical of engineering work as it really exists and on the scale of practice. The function of the laboratory in the college should be to teach habits of observation, to teach methods of thought, to teach the fundamental laws which underlie all the numerous apparatus with which the young engineer will sooner or later come into contact, and to prepare in his mind a receptiveness for the serious lessons of practice. This practice can be had in the workshop, the central station or on the railway line to real advantage; but the student who imagines that he knows it all when he leaves college will find himself suddenly and harshly disabused when he goes out to earn his living by the application of his knowledge.

The time is coming for a reform in methods of engineering instruction. If we can teach a young man to think, and if he has that combination of originality, mechanical talent and application which is necessary for an engineer, he will become one as soon as he has seen enough actual work to make himself familiar with it. But the principles of engineering can not be sugar-coated for the student in the laboratory, nor can he commit them to memory, parrot-like, and apply them with effect afterward.

If it could be thoroughly understood that the function of a technical institute is simply to prepare young men to absorb, with the best possible effect, the lessons of practice and that the course of some years in the classroom and the laboratory must be supplemented by a course in the machine-shop, the foundry, the central station or what not, the result would be

the training of a race of engineers of ability and capacity. The result of the present method, which turns out hundreds of young men annually—half equipped and imagining themselves fully prepared for their duties—is already beginning to exhibit results which it is not necessary to recount here. Suffice it to say that the number of engineering graduates to-day is in excess of the number of possible situations open to them. While it is likely that the instruction given does no particular harm to the student, the increasing speed of life and the increasing sharpness of competition absolutely require the most economical use of the student's time for learning. To take three years of a young man's life and apply them to anything but the most substantially useful pursuits is to rob him of something that can never be given back nor in any way compensated.

SOME PRESENT ENGINEERING TENDENCIES.

Human beings are gregarious animals, and whether it be in the matter of the clothes they wear or in the engineering designs they produce, fashion rules with a supreme and arbitrary hand.

Aside from the dictates of engineering fashions, however, there are certain marked tendencies which differentiate one period from another and show the general trend of the engineering mind from time to time. Just at present the habit of American electrical engineers has become fixed along certain directions, and strange to say one of these is an extreme conservatism.

About the time that electrical manufactures became an important industry in the United States, the idea of standardizing all parts and product became uppermost in the minds of designers and engineers of works. The consequence was that practically all manufacturing establishments reduced their output to its simplest terms, and adhering faithfully to the standard dimensions chosen really gave the world its first lesson in actual manufacture of machines. The distinguishing mark of this product was that it was manufactured, not made. In addition to the extraordinary convenience to the user which interchangeable parts gave, there was also a very great reduction in the cost of manufacture, due to the economies which could be applied to manufacture in bulk and which were not capable of application when the product was turned out piece by piece or with much hand-work. So, after a while, interchangeable parts and manufacture to gauge and standard became a sort of hall-mark of American product, and this was shortly supplemented by an ever-increasing attention paid to mechanical strength in the apparatus produced.

It seems, in looking back over old machine designs, as if many of the ideas upon which the pioneers based the plans for their machines came from the French. There is the typical lightness and elegance of form, combined with that peculiar carelessness about structural strength, which is characteristic of our transatlantic neighbors. But as the machinery was put to work a noticeable change crept into the typical design, and to-day our electrical apparatus is probably as massive, as strong, and as capable of withstanding ill usage and severe conditions as any that can be made.

Another tendency has been in the direction of magnitude. We have built the biggest apparatus ever attempted; sometimes, perhaps, one may think without reference to whether this is the best at the same time. At any rate, as other pages of this issue will show, we have lately luxuriated in size and have constructed electrical machines each of which is of the capacity of half a dozen city central stations of some years ago.

The tendency, however, of all others most noticeable to-day is conservatism—a thing so foreign to our character and so unexpected that it is not easy to account for its appearance or to understand its limits. It seems as if, after passing the period of pioneer work—the early days of the youthful enthusiasm of electricity, so to speak, our engineers have suddenly acquired old age and with it the caution, if not the wisdom, that comes with that state. Be this as it may, for two or three years we have noticeably been delaying and holding back to allow experiments in engineering to be conducted by our European competitors. If the spirit which built the Richmond road, which started the first central station in New York, and which sunk millions after million in the depths of the Atlantic in the endeavor to lay a working cable, were still with us it is a certainty that we would not allow the French, the Swiss, the Germans and the Hungarians to be first in experimenting with alternating current for railroad purposes.

ELECTRIC FANS.

On other pages of this issue are illustrated and described a number of types of electric fans designed for the season of 1902. It will be noticed in comparing these with the types of former years that there has been little change, the reason being that the electric fan has now reached a point of great perfection and has become practically standardized. The history of its invention is curious and entertaining. The credit appears to belong to Dr. S. S. Wheeler, who was one of the pioneers in the manufacture of small motors. To one of these one day he attached a contrivance resembling a screw propeller, and for the first time the gentle breeze of the electric fan was felt.

The fan soon blew itself into popular regard. We are a comfort loving people and the fan, regarded for a while as a pleasant luxury, very soon came to be looked upon as nothing short of an absolute necessity. The business which has been done in manufacturing electric fans is very large, while in the summer time, when the daylight hours are long and the lighting load on central stations is small, the fans have proven a source of no little revenue and profit by providing a good daytime custom for the station.

Curiously enough the fan, a purely American invention, has only just begun to be recognized abroad. Last year in India in many places the time honored *punkah,* with the proverbially sleepy oriental to work it, was replaced by the whirling electric fan. In Paris the fan has been introduced in some places, noticeably those where Americans congregate, but is looked upon askance by the natives who prefer to do their own fanning. Still it is believed that the fan will ultimately prevail, because no man can long resist its seductions in hot weather. Here, in our semi-tropical summers, it has proven not only a convenience but has actually been a valuable addition to means of comfort, particularly in hospitals and sick rooms and in crowded workshops and elsewhere where suffering from the summer heat is always intense.

The various types of fan motors illustrated in this issue have been developed by an experience of several years of service and represent probably the perfection of small electric motor apparatus.

The Electrical Review.

THIS journal made its first appearance February 15, 1882. It was named the "Review of the Telegraph and Telephone." It was published semi-monthly under this title for one year, when the name was changed by the founder to "Electrical Review," under which title it has been published as a weekly journal ever since.

Mr. George Worthington was the founder and editor from February 15, 1882, until his retirement on account of failing health in 1891. He died February 3, 1892, one week previous to the "Electrical Review's" celebration of its "Decennial" or tenth anniversary.

The first publication office was 23 Park Row, New York, and the offices have always been on Park Row. J. W. Pratt & Company were the printers who turned out the first copy and were responsible for the typographical and press work until 1888, when a change was made to the James Kempster Printing Company, by which house the ELECTRICAL REVIEW has continued to be put in type, printed and bound.

As will be seen from the facsimile pages presented in this issue the first article is a poem by Thomas S. Collier, taken from the *Boston Transcript*. It is presumed that the last two lines of this versification were to be considered as the motto of this journal:

"On every banner blazon bright,
For toil, and truth, and love we fight."

A short poem was the introduction on the first page during the first year.

The first issue consisted of sixteen pages. This size was continued for several years. When the name was changed to ELECTRICAL REVIEW the size of the page, however, was considerably enlarged.

The editorial introduction February 15, 1882, was in part as follows:

In this practical age progress is so rapid that, to give currency to new ideas and improvements as they obtain a foothold, nearly every large class of business has its representative newspaper, and, in many instances, several acknowledged journals, each treating wholly upon the topics pertaining to its specialty.

With the best facilities at our command, we propose to make this the standard telephonic and telegraphic journal of America, and to this end shall direct all our efforts.

We shall also treat the subject of electric lighting fully, and illustrate the merits of the systems now accepted and in general use.

The present seems a peculiarly fitting period to start out upon the territory we have chosen.

The genius that has distanced the old world in useful and invaluable electrical inventions will brighten still more under the influence of these auspicious times of rapid advancement and activity in these branches of the electrical science.

To keep our readers informed as to the most important and valuable inventions pertaining to these subjects, giving suitable illustrations of new objects and discursive reviews of the same, is the principal purpose of this journal.

To our many friends and patrons, who have so fully and so gratifyingly sustained and encouraged us in this undertaking, we return our sincere thanks, with assurance that their confidence is not misplaced.

The first issue contained a contribution from Professor John Trowbridge on "Extension of the Signal Service." Prof. Trowbridge has continued to be and is to-day one of the ELECTRICAL REVIEW's most esteemed contributors. Of the sixteen-page journal two pages of the first issue were devoted to advertising. These pages are reproduced in facsimile elsewhere. At the end of the first year eight pages were devoted to advertising, the number of houses thus represented having increased from seven to fifty. Among those represented in the advertising columns, who are in business to-day, with slight changes perhaps in the titles of some, were: Holmes, Booth & Haydens, the Ansonia Brass and Copper Company, Partrick & Carter, J. H. Bunnell & Company, Alfred F. Moore, Bishop Gutta-Percha Works, the S. S. White Dental Manufacturing Company, Westinghouse Machine Company, John A. Roebling's Sons Company, Phosphor-Bronze Company, Davis & Watts, Western Electric Company, Leclanche Battery Company, the American Bell Telephone Company, Kerite Insulated Wire and Cable Company and the American Electrical Works.

Although no announcement of Mr. Worthington's associates appeared during the first year, among the regular staff contributors were: Dr. Franklin H. North, of New York; Dr. Henry A. Bunker, of Brooklyn, and Mr. Thomas D. Lockwood, of Boston.

The Paris correspondent made his debut on June 1, 1882, and wrote interestingly of technical matters in that city.

The first issue of the ELECTRICAL REVIEW as a weekly journal appeared March 22, 1883. It was published by Delano & Company, with Mr. George Worthington as editor and Mr. Thomas H. Delano as publisher. The editorial announcement of this change said:

With this number the REVIEW OF THE TELEGRAPH AND TELEPHONE begins its career as a weekly under a shorter and more comprehensive title, *viz.*, THE ELECTRICAL REVIEW.

In one short year this journal has advanced step by step from a puny infant until now, at the beginning of its second year, it stands the acknowledged representative of the American electrician. But it is not alone in America that the journal has been received with marks of popular approval. Our foreign files and the numerous letters we have received from Great Britain and the Continent indicate, beyond peradventure, that it is recognized on the other side of the Atlantic as the accredited exponent of electrical progress in America.

The new name has been found to better express the aims of the journal, since the latter does not represent alone those interested in the telegraph and telephone, but also everybody interested in the application of electricity in any form.

The editorial staff has been increased, as well as the number of correspondents both here and abroad, and the enlarged edition, printed weekly, will be distributed throughout America and Europe.

The subscription price of the ELECTRICAL REVIEW was increased at this time from $2 per annum to $3 per annum, which is the subscription price to-day.

On April 26, 1884, Mr. William A. Hovey, of Boston, joined the editorial staff of the ELECTRICAL REVIEW. Mr. Hovey remained as associate editor until 1885. In the latter part of 1884, Mr. Delano retired as publisher.

During 1884 a stock company known as the ELECTRICAL REVIEW PUBLISHING COMPANY was formed with Loren N. Downs, president, and George Worthington, secretary and treasurer. This company, with some changes of officers, has continued the publication of the ELECTRICAL REVIEW from that day to the present.

On May 24, 1884, the ELECTRICAL REVIEW announced that it had "purchased the good will, copyright and subscription list of the *Electric Light*, a paper devoted to electrical interests, which has been published in Boston during the past six months. This purchase makes a material addition to our subscription list, and a most desirable increase in the circulation of the ELECTRICAL REVIEW."

This was the only consolidation with which the ELECTRICAL REVIEW ever had anything to do.

During 1883 the present editor became

associated with the ELECTRICAL REVIEW as correspondent. In 1885 he accepted the position of associate editor and succeeded to the editorship in chief on the retirement of Mr. Worthington in 1891. In addition to the names of the editor and associate editor the names of C. C. Haskins, of Chicago; George A. Hamilton, John W. Beane and George H. Benjamin, of New York, appeared in the editorial announcement of the ELECTRICAL REVIEW as consulting electrical engineers.

September, 1887, a department devoted to patent work was organized and conducted for several years by Mr. T. J. McTighe, who was succeeded later by Mr. Robert H. Read. Mr. Read continued in charge until the patent bureau was disposed of to a firm of patent attorneys in New York.

In 1887 the ELECTRICAL REVIEW offices were moved to 13 Park Row, and remained at that number for nine years, then were moved to 41 Park Row, and in the fall of 1900 returned to the former location at 13 Park Row, where the largest office building in the world had meanwhile been erected. The three locations are portrayed on this page and give a good idea of the change that has taken place in the size of office buildings in New York city and, perhaps, give an indication of the changes and advances made by the ELECTRICAL REVIEW.

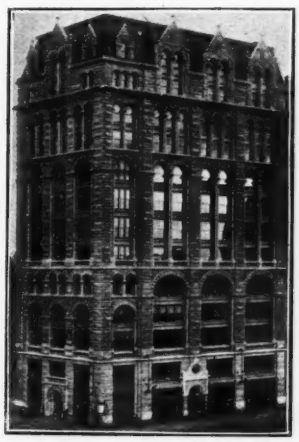
13 PARK ROW—1887-1896.

is second to that of no other technical publication.

The active staff of the ELECTRICAL REVIEW, exclusive of its clerical force, consists to-day of the following named persons:

Charles W. Price, president and editor.
Stephen H. Goddard, secretary.
Charles T. Child, technical editor.
Russell Howland, general representative.
A. A. Gray, assistant editor.
H. S. Tuthill, cashier.
W. H. Evans, manager subscription department.
J. H. Marsh, subscription agent.
James F. Crook, western representative.
A. Webster, London correspondent.
Enrico Bignami, Continental correspondent.

In addition to the above named, the ELECTRICAL REVIEW has a large staff of contributors among the leading electrical writers and scientists of this country and Europe.



39-41 PARK ROW—1897-1900.

13-21 PARK ROW—PRESENT OFFICE.

THREE DIFFERENT PARK ROW HOMES OF THE "ELECTRICAL REVIEW," TYPIFYING BUILDING CHANGES IN NEW YORK CITY, AS WELL AS THIS JOURNAL'S GROWTH.

In 1890 Mr. Stephen L. Coles became a member of the staff of the ELECTRICAL REVIEW, remaining as associate editor and managing editor until he retired in 1901. In 1890 Mr. H. T. Richards also joined the staff of the ELECTRICAL REVIEW, as manager of the advertising department, and later was succeeded by Mr. Stephen H. Goddard, who is to-day in charge of that department, and is secretary of the ELECTRICAL REVIEW PUBLISHING COMPANY. Mr. Russell Howland joined the permanent staff a few years later.

Mr. Charles T. Child in March, 1899, became technical editor of the ELECTRICAL REVIEW. The standing of the ELECTRICAL REVIEW on engineering and scientific matters, it can be stated with propriety,

SOME INCIDENTS OF A JOURNAL'S LIFE.

It is desired to set down here a simple and modest tale of a few of the things the ELECTRICAL REVIEW has accomplished during its twenty years of life, in assisting, with many other influences, in the advancement of the electrical arts of this continent.

The first volume of this journal, beginning February 15, 1882, and ending March 1, 1883, was a record of the electrical progress and electrical events of that period. In the numbers comprising the first volume five illustrations appeared, the first being Professor Elisha Gray's "Harmonic Telegraph," April 15, 1882; the second Professor Dolbear's illustrated lecture on the "Operations of the Telephone," and the other three the "Kabath Secondary Battery," "Induced Currents," by F. W. Jones, and the electric boat "Electricity," which was launched on the Thames River, London, in December, 1882. A heavy snow in February, 1882, is reported to have interfered with the operations of the Edison electric railway at Menlo Park, N. J., and numerous allusions also appeared to the work of Mr. Edison in installing his Pearl street station for incandescent electric lighting. Telegraph and telephone and electric light matters received extensive notice throughout the volume. A wail from a telephone operator, indicating troubles of that day similar to the troubles of the present, states that "the proper requisites of a telephone operator are the energy of despair, the patience of Job, the wisdom of Solomon and a cast-iron ear."

The announcement is made on June 15 of the fitting up of the rooms of the New York Electrical Society in the building of the Metropolitan Telephone and Telegraph Company, at the corner of Liberty and Greenwich streets, under the "creditable management" of Messrs. H. W. Pope,

E. C. Cockey and M. N. Doran. It was announced that "Professor Edison, Professor Gray, David Brooks, Professor Dolbear, C. L. Buckingham, and many other scientists, have intimated their readiness to contribute papers or lectures at an early day. We congratulate this young society on its bright prospects and bid it God speed."

On September 1, announcement was made of the proposed meeting of the National Telephone Exchange Association, which had been organized in September in 1880. The officers in 1882 were: President, George L. Phillips; vice-president, William H. Eckert; secretary, Morris F. Tyler; and the executive committee consisted of Messrs. W. D. Sargent, George C. Maynard, Edward J. Hall, Jr., C. N. Fay and others. A full report of the meeting, which was held at Boston, September 5, was published September 15. The announcement of the programme included such ever-familiar subjects as "Legislation," "Central Office Apparatus," "Exchange Statistics," "Line Construction and Maintenance," "Cables and Subterranean Systems," and "Electrical Disturbances and Exchange Rates."

It is shown that in the year 1882 no less than 1,153 electrical patents were issued, of which 258 related to electric lighting, 141 to telephone apparatus and appliances, 110 to magneto and dynamo electric machines, eighty-six to conductors and cables, fifty-four to batteries, and the rest distributed throughout the various branches of electrical work, included twelve patents on lightning rods and lightning arresters.

A test of Edison's electric road is published April 1, 1882, and states that:

Mr. Edison's track is like that of any ordinary railroad, involving curves, grades (one over thirty feet to the mile), with the various obstacles of the ravines, streams and rocks. The car resembles our modern horse car. The electricity is communicated from the generators, some 300 yards away, by two heavy wires, one connecting with each track. The tracks are insulated by covering the ends of the ties with a non-conducting compound. The wheels take up the electricity from the tracks and communicate with the dynamo-electric machine and gearing in the locomotive. Thus is given to the train a noiseless, rapid, pleasant motion, unattended with smoke, cinders and clatter.

The volume concludes with an excellent article on "Electric Lighting in Mills," by Mr. C. J. H. Woodbury, of Boston, Mass.

All technical and social organizations mentioned in the first volume received much consideration, and it was the evident intention of the editor constantly to promote their welfare. The monthly meetings of the New York Electrical Society are mentioned at length and also the annual and special meetings of the National Telephone Exchange Association.

In the ELECTRICAL REVIEW of March 22, 1883, it is announced that "a convention of the Brush electric lighting companies will be held in Cincinnati, Ohio, April 10, for the purpose of selecting an incandescent lamp to be used with their storage batteries."

Electrical litigation had already made its appearance and became more intense during 1883. The chief litigants were the various telephone claimants against the Bell interests and several manufacturing electric light companies.

An illustration of the Providence telephone exchange appeared in the ELECTRICAL REVIEW of May 10, 1883, and is reproduced this week. It is interesting to compare it with the telephone exchanges of the present day, some of which are pictured in this issue. The Providence exchange was one of a type of the best exchanges of the day, although at about that time the introduction of the multiple switchboard began and was a complete revolution in the telephone central offices.

An editorial on "Electric Motors and Tunnels" appeared May 10, concluding with the statement that "the belief is prevalent that two tunnels might have been constructed under the East River with the money expended for the Brooklyn Bridge, and the use of electric motors in them would afford better means of transportation than the cars of the Brooklyn Bridge."

It may be remarked that no mention had as yet appeared in the ELECTRICAL REVIEW editorially or by any correspondent to the effect that "electricity was still in its infancy." This trite saying seems to have been reserved for a period of from fifteen to eighteen years later.

The telegraph companies began to announce at this time that messages were "transferred by telephone at the sender's risk." "Old subscriber" began to write to the press that "can't raise them" was beginning to be heard with too much frequency on the telephone lines as the reply from central offices.

A prophetic note appears in the ELECTRICAL REVIEW of May 4, 1883, as follows: "If the experiments made by Deprez in Paris recently mean anything at all they mean that electrical energy is to be generated upon the banks of running streams of waterfalls, or at coal mines where fuel is plentiful, and conveyed to points distant where light, power and heat are needed." It is scarcely necessary to point out that this writer was a true prophet.

A complaint is chronicled on the same date because "incandescent lamps were not larger."

The danger to life of linemen in the West is described and makes quite a gruesome picture. It seems that Indians, desperadoes and idlers in general throughout several of the western states, notably Colorado, were in the habit of cutting down the poles and wires of the telegraph and telephone companies, and if the linemen interfered they were promptly shot. As typical of the danger it is related of a superintendent of a railroad company, who, on being asked by an applicant for the position of brakeman if there was any vacancy, replied, "Not at present. Sit down for a few minutes and there will be one killed." The energetic work on the part of the telephone and telegraph companies in bringing the Indians and desperadoes to punishment soon changed the condition of things.

The first mention of an electric underground cable company, located in Chicago, appeared in June, 1883.

It was announced June 7, 1883, that the Metropolitan Telephone and Telegraph Company (now the New York Telephone Company) had "3,500 subscribers connected." This company has, to-day, over 70,000 telephone subscribers.

The organization of numerous electric lighting companies and telephone operating companies is recorded during 1883. The Edison Electric Illuminating Company of Boston, and the Erie Telegraph and Telephone Company, of Lowell, Mass., were two of the important organizations. The Thomson-Houston Electric Company, of Boston, Mass., entered the field as a manufacturer of electric lighting apparatus early in the year, and others in the field were the United States Electric Light Company, manufacturer of the Weston arc light and the Maxim incandescent lamp, Brush Electric Company, Edison Company, Van Depoele Electric Light Company, Schuyler Company, etc.

A trial of an electric omnibus, made in Paris, with a fair degree of success, was reported September 20, 1883.

Hon. W. M. Evarts is reported as being opposed to the burying of the wires and is said to have protested against it in a sentence of 152 words!

In its issue of January 3, 1884, the ELECTRICAL REVIEW throws a little bouquet at itself in the following editorial:

(Continued on page 197.)

FACSIMILE OF FIRST READING PAGE.

NEW YORK REVIEW OF THE
TELEGRAPH AND TELEPHONE
AN ELECTRICAL JOURNAL.

Vol. 1, No. 1.—Copyrighted 1882.] NEW YORK, FEBRUARY 15, 1882. [$2.00 Per Annum. Single Copies, 10 Cents

Epigrammatic.

From the Boston Transcript.

He wins at last, who builds his trust
In loving words and actions just.

The winter blast is stern and cold,
Yet summer has its harvest gold.

Sorrow and gloom the soul may meet,
Yet love wrings triumph from defeat.

The clouds may darken o'er the sun,
Yet rivers to the ocean run.

Earth brings the bitterness of pain,
Yet worth the crown of peace will gain.

The wind may roar among the trees,
Yet great ships sail the stormy seas.

Full oft we feel the surge of tears,
Yet joy has light for all the years.

On every banner blazon bright,
"For toil, and truth, and love we fight."

THOMAS S. COLLIER.

The Teleradiophone.

M. Mercadier, the eminent French electrician, has ingeniously adapted the photophone of Professor Bell to telegraphy. In the Photophone a ray of light is reflected by a mirror, so as to fall upon the sensitive surface of a "selenium cell" joined up in the circuit of a voltaic battery and a speaking telephone. When the light strikes the cell its electric resistance is diminished, and a wave or pulse of current flows through the telephone, causing it to sound. By eclipsing the ray of light a great many times per second, this sound can be exalted into a continuous hum, like that of a tuning-fork, and by again occulting the intermittent ray for long and short intervals corresponding to the flashes of a signaling lantern, this hum or drone can be broken up into audible signals. Thus, if the Morse telegraphic code is used a short occultation, producing a short pause in the note of the telephone, will stand for a "dot," and a long occultation, producing a long pause, will stand for a "dash" This photo-electric telegraph is realized by M. Mercadier with the help of a gas flame forming the source of light, a mirror and lenses to direct its rays upon the selenium cell in circuit with a battery and the line wire. The beam is regularly eclipsed by means of a rapidly rotating disc, perforated with a circle of holes, and the telegraphic occultations of the intermittent beam are effected by means of a signaling key, which interposes a dead screen in the track of the light whenever the key is pressed. These apparatus form the transmitter, and the receiver at the other end of the line is of course the telephone, which is fitted with a resonator to reinforce the sound. There is no gain in such an arrangement over the ordinary telegraph now in use; but it has the merit of lending itself to multiple telegraphy. Thus by multiplying the number of transmitters at one end of the line and the number of telephones at the other, several different messages can be sent along the same wire at once. In order to do this it is only necessary to rotate the eclipsing wheels at different speeds, so as to produce notes of different pitch in the receiving telephones, and to fit each resonator so as to enhance a particular note. Then, although the complex current flows through all the telephones in turn, each telephone will only render to the ear of the clerk the particular note for which he listens, and the makes and breaks of that note will be interpreted as the message. Not only can several messages be sent in one direction along the same wire together, but from opposite ends simultaneously without confusion, and M. Mercadier reckons that with 10 transmitters and 10 receivers at each end of a line, he can send 200 dispatches of 30 words each per hour, or 100 words per minute, in either direction. The effects of induction, so troublesome in speaking by telephone, are not experienced in this process, owing to the employment of musical notes and resonators.

The Arago Dynamo-Electric Generator.

Among the numerous dynamo electric generators shown at the recent Paris Electrical Exhibition were two machines of American origin, which, under the name of the "Arago Disc Dynamo," were exhibited by the Whitehouse Mills Company, of Hoosac, New York. It comprises, as will be seen, two pairs of electro magnets, each having one end attached to the frame of the machine, and the other ends opposite to each other; these magnets are so wound that they present alternate polarities, and the polarity of each pair of magnets facing one another is of an opposite nature. The magnets are provided with sector-shaped pole pieces, which collectively form the greater part of a disc. Each pair of magnets having such pole pieces opposite to one another, it will be seen that, as they stand in the machine, they leave between a narrow parallel space. Within the magnet thus formed revolves a wheel or disc, in which are mounted a series of six sector-shaped bobbins. All six of these coils are wound in one direction, but are coupled up in such a way that a current passing through them in series would circulate through them in opposite directions. The six coils are held in positions by two plates on the driving shaft, and by the double copper ring that forms the periphery of the wheel.

The second and larger machine is constructed on the same principle, but involves more complication. In this generator there are six pairs of electro magnets, arranged as in the smaller machine, and furnishing six alternating magnetic fields. The revolving disc is also as already described, only it has eight coils with wooden cores. The commutator consists of 24 plates. The means employed for rendering the current continuous is the same in principle as that used in the Hefner Altenek machine. The space comprised between two coils of the disc is connected to three plates of the commutator in such a way that the latter forms three groups of eight plates each. The two brushes are always in contact with two plates corresponding to the line that divides the induction coils in two equal parts traversed by opposite currents. The armature of this machine has a special arrangement which does not belong to the smaller one; each of the coils of the armature is in two parts. The induced current set up in the more important of these parts produces a current that is thrown into the circuit of exterior work. The induction produced in the other portion creates a current that excites the electro magnets On account of this arrangement the collector is divided into two distinct parts, each corresponding to one of the circuits just mentioned. The brushes are mounted in a special way; their supports are fixed on a ring beyond the frame of the machine, and the brushes themselves are also carried by springs fixed to the ring. From the foregoing description it will be seen that the Arago disc dynamo is a self-exciting generator, the arrangement adopted involving the use of two sets of brushes and two commutators—one connecting the magnets with the exciting coils, and the other connecting the induction coils and the outer circuit. The frame on which the brushes are mounted can be turned round through a considerable angle, so as to adjust the brushes to the position of highest efficiency. It is stated that the larger of these machines, driven at a speed of 1,000 revolutions, can feed eight arc lights of average intensity, consuming about six horse power, but accurate data as to its capacity are wanting.—*Engineering, London.*

Telephone Conductor.

Mr. Edward Truman, of London, has been engaged on the manufacture of a good telephone conductor, composed of two or more wires, his object being to obviate induction. Mr. Truman constructs his conductor on the metallic circuit system of two wires wound in a spiral form, placed in one covering, the wires being kept equidistantly apart, and insulated from one another. He can, however, make his conductors so that they shall contain as many as six or even more wires, all of which shall be equidistant from one another, and insulated. One of the conductors, a mile long, containing six wires, said to be insulated from one another by about 6,000,000,000 of units, and from the water in which the conductor was laid by as many as 13,470,000,000 of units per statute mile, was recently tested at Mr Truman's works at Vauxhall by some of the Post Office officials. The core of these conductors is made of solid gutta percha.

M. Cochery intends to spend the surplus of the Electrical Exhibition fund, which exceeds £16,000, in establishing a research laboratory of electricity.

FACSIMILE OF FIRST EDITORIAL PAGE.

NEW YORK REVIEW
OF THE
Telegraph and Telephone,
(ELECTRICAL JOURNAL)

PUBLISHED SEMI-MONTHLY AT 23 PARK ROW.

P. O. BOX, 3329.

GEORGE WORTHINGTON, - PROPRIETOR.

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EDITORIAL ANNOUNCEMENT.

We invite correspondence from Electricians, Inventors and the Telegraph and Telephone fraternity on matters pertaining to electrical and scientific subjects, and all facts of special interest in connection therewith.

Those desiring to recommend their goods can do so to any extent in our advertising columns, but we will not publish for pay anything of that nature in our reading columns.

Subscribers can at any time have the mailing address of their paper changed by sending both old and new address.

NEW YORK, FEBRUARY 15, 1882.

EDITION, 4,500 Copies.

In this practical age progress is so rapid that, to give currency to new ideas and improvements as they obtain a foothold, nearly every large class of business has its representative newspaper, and, in many instances, several acknowledged journals, each treating wholly upon the topics pertaining to its specialty.

There are several journals claiming recognition in the electrical field, but not one that confines itself exclusively to these vast and important interests.

Recognizing the want of a *live*, enterprising journal to represent the Telephone and Telegraph as a distinct branch of business, we present this our first issue of the NEW YORK REVIEW OF THE TELEGRAPH AND TELEPHONE AND ELECTRICAL JOURNAL.

With the best facilities at our command, we propose to make this the standard Telephonic and Telegraphic Journal of America, and to this end shall direct all our efforts.

We shall also treat the subject of Electric Lighting fully, and illustrate the merits of the systems now accepted and in general use.

The present seems a peculiarly fitting period to start out upon the territory we have chosen.

The genius that has distanced the old world in useful and invaluable electrical inventions will brighten still more under the influence of these auspicious times of rapid advancement and activity in these branches of the electrical science.

To keep our readers informed as to the most important and valuable inventions pertaining to these subjects, giving suitable illustrations of new objects and discursive reviews of the same, is the principal purpose of this journal.

At the same time we shall always act independently, not holding ourselves under the least obligation to give "favorable notices" of anything under review, but rather to elicit the plain truth whether it be favorable or unfavorable.

Every review of an electrical object that appears in our columns will be prepared by a thoroughly competent party after a satisfactory examination.

To our many friends and patrons, who have so fully and so gratifyingly sustained and encouraged us in this undertaking, we return our sincere thanks, with assurance that their confidence is not misplaced.

The Multiple Switch Board for Telephone Exchange Offices.

The attention of the public has been drawn to the fact, recently, by the newspapers, that the rates for telephones in the larger cities were much higher in proportion to the number of subscribers connected, thus reversing the usual rule of business, according to which the more of any given article, or any service, that is called for and furnished, the cheaper it can be obtained. The reason for this appears upon very slight investigation; for, while the number of subscribers of a telephone exchange is only one hundred and fifty to two hundred, the number that can be called for at any one time can easily be managed, and the operation required for making the connection be done by perhaps a single boy or girl.

When the number of subscribers is larger, however, it will be seen that the number of connections that can be called for increase rapidly, and consequently the work of making the connections.

To meet the increased difficulties of handling large numbers of subscribers, various means have been suggested and tried, but none have theoretically or practically promised the success of the duplicate switch board.

The duplicate switch board, described briefly, is a means for making the terminals of the wires of subscribers appear at different boards, and be operated without interference.

The ingenious means by which this result is obtained we hope to describe more fully later, but at present it is sufficient to say that in practice it has been successful to use separate boards for the terminals, and that they have been operated without interference, thus enabling the switchman at either board to know at once whether the party wanted was busy, and, if not, to make the connection.

At the Telephone Exchange office, in Indianapolis, where the system has been most perfectly tried, the manager speaks most highly of this system. The time occupied in making the connection is less, probably, than that required in the ordinary telephone exchange of fifty or one hundred subscribers. In Chicago, also, the system has been tried, and has found favor, though the most improved apparatus for the purpose has not there been introduced.

As the telephone continues to grow in favor with the importance of the service in large cities, the question of the adoption of the duplicate board is only one of time.

The system, as is signified by the title, "Multiple Board," can be adapted to the use of three or four boards for the terminals of the wires, all working independently of each other. The practical telephone men have no difficulty in understanding the advantage derived from the distribution of force allowed by this board.

The Electric Railroad.

The snow fall has seriously interfered with the work of the new electric railway at Menlo Park. This is expected to reach completion in about two months. Its length will be about three miles, running from Menlo Park towards Plainfield, N. J.

Induction on Telephone Circuits.

One of the most effective remedies discovered as yet for getting rid of induction on telephone circuits has been devised by the French electrician, Foucault, who wraps the telephone wire with any good metallic conductor, such as tin foil, and connects the wrapping at intervals of every few miles with the earth. The current induced from other wires affects first the metallic wrapping, and as the tendency to seek the earth is stronger than to affect the wire, it runs to the earth. It has been found, however, that over long distances this metallic wrapping produces what is technically known as "retardation," the current becoming sluggish and unmanageable.

The Electric Light has come home, not only to the business but to the bosom of the whole civilized world. It is an interest which, like the sunlight itself, permeates everywhere, and is felt by everyone. It tells its own story to high and low, rich and poor, and carries its uses and conveniences to them all. It is already a familiar illumination in the cities of Europe and America, but the further it extends along the public streets and spreads into institutions, manufactories, shops, private dwellings everywhere, the more will invention and contrivance have to follow it, and the more will the people desire to be kept abreast with its progress by a faithful, popular, and scientific account of every step it makes on the way.

We tender our thanks to Horace B. Miller, Esq., and his able and efficient colleagues of the *American Machinist*, for their excellent counsel concerning the publishing business.

Our Telephone friends will be greatly benefited we think by subscribing to this REVIEW, as it will present to them semi-monthly all the *latest* and most important news concerning their particular branch of business, and all new inventions and improvements in instruments, and all appliances and apparatus used in Telephone Exchanges worthy of mention will be carefully examined and illustrated in this Journal.

We shall endeavor to uncover and show up the true inwardness of the organizers of a certain *soi-disant* Electric Light Company in our next issue; the matter came in too late for notice in this edition.

We regret that we are obliged to omit some articles, of interest to Telegraphers and our Telephonic friends, from this issue which did not reach us in time for publication.

A Canal to be Lighted by Electricity.

OTTAWA, Feb. 9.—The newly constructed part of the Welland Canal, for a distance of nine miles, is to be illuminated by electric lights.

The heading of our REVIEW, of which we are somewhat proud, was executed by that Master Artist Penman, Daniel T. Ames.

Everything worth noting of interest to the patrons of THE TELEPHONE AND THE TELEGRAPH will be found in this paper.

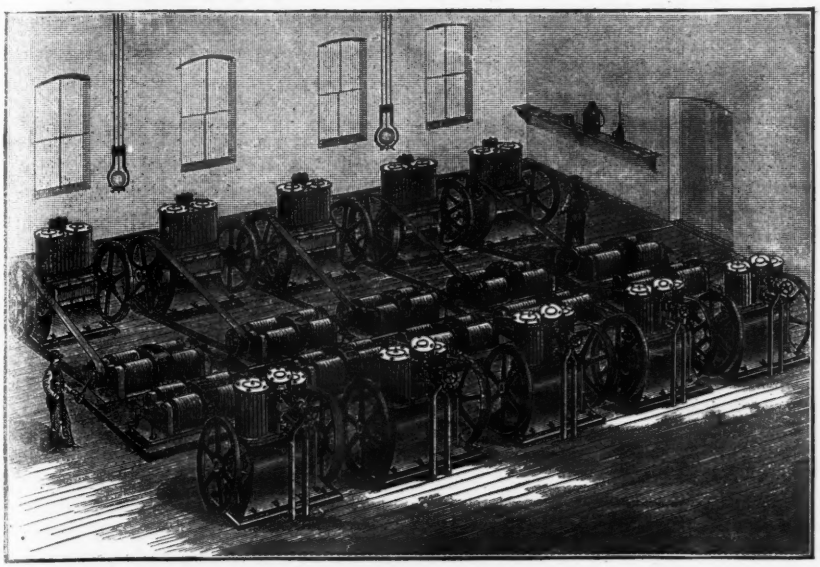
When purchasing supplies of our advertisers we shall be obliged if you will kindly mention that you saw their advertisement in this paper.

Address all communications intended for this paper to George Worthington, proprietor and publisher, 23 Park Row, P. O. Box 3329, New York.

THE ELECTRICAL REVIEW.

(Continued from page 194.)

"The publishing department of the REVIEW has been conducted on strict business principles, and a side glance at the advertising pages will show that we may justly be proud of it. Every advertisement in the columns of the ELECTRICAL REVIEW is *bona fide*. It was inserted at the request of the advertiser, and is paid for in accordance with a regular scale of rates, from which, with like conditions, we never depart. Look the advertising columns carefully through, and you will find no notices of quack medicines; you will find no puffs of children's toys, nor of old ladies' cough drops. We don't advertise chest protectors, nor rat poisons, nor cures for rheumatism, nor visiting cards or the like. If you want a cure for any of the ills to which human flesh is heir, don't look in the ELECTRICAL REVIEW, because it is not devoted to pills, potions and pungencies. But if you want the address of a reputable house where you can obtain electrical goods of any description, you will find it without trouble in these pages."



THE BRUSH ELECTRIC LIGHT COMPANY'S STATION AT BUFFALO, NEW YORK.
Reproduced from the ELECTRICAL REVIEW of June 28, 1884.

The discussion as to the burial of electric wires again came to the front under such headings as "Shall the Wires be Underground and Telephone Service Discontinued," "The Poles to Stand," "Legislative Unreasonableness," etc. The discussion grew in earnestness.

The American Institute of Electrical Engineers, the leading electrical organization in the United States to-day, elected its first board of officers May 13, 1884. The following gentlemen were elected:

President, Dr. Norvin Green.

Vice-presidents, A. Graham Bell, Charles R. Cross, Thomas A. Edison, George A. Hamilton, Charles H. Haskins, Frank L. Pope.

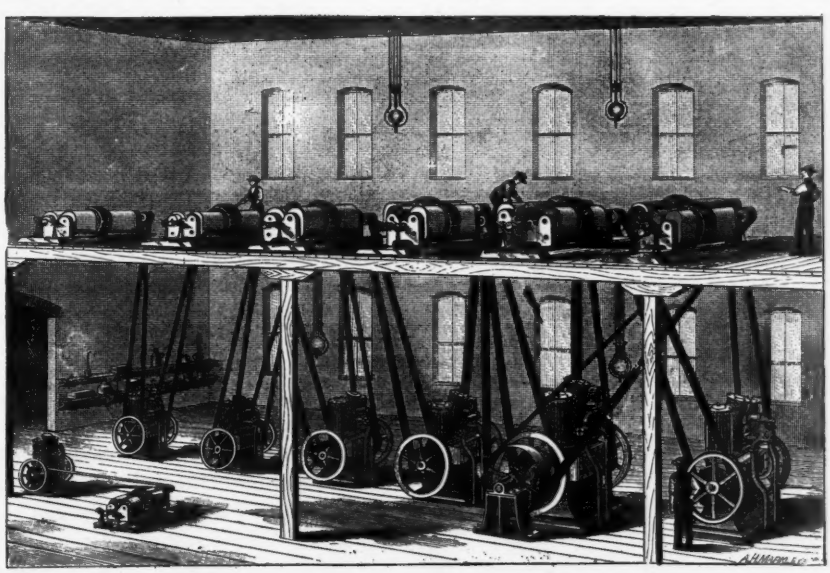
Managers, Charles F. Brush, William H. Eckert, Stephen D. Field, Elisha Gray, Edwin J. Houston, C. L. Hillings, Frank W. Jones, George B. Prescott, W. W. Smith, W. P. Trowbridge, Theodore N. Vail, Edward Weston.

Treasurer, Rowland R. Hazard.

Secretary, Nathaniel S. Keith.

The ELECTRICAL REVIEW gave editorial endorsement of the Institute the following week, and thus was launched probably the most influential and authoritative organization of the electrical field.

On August 9, 1884, mention of Mr. Stephen D. Field was made and a short notice relative to the securing of patents for his electric railway systems, over Siemens and Edison, was published.



THE ALLEGHENY COUNTY ELECTRIC LIGHT COMPANY'S STATION, PITTSBURGH, PA.
Reproduced from the ELECTRICAL REVIEW of June 28, 1884.

The electrical exhibitions at Philadelphia and Boston are reported at some length and were evidently largely attended; they were highly creditable exhibitions of the electrical apparatus of that day.

By this time a number of insulated electric wires had entered the manufacturing field to supply the increasing demand. The manufacturers of bare copper wire had on several occasions brought out insulated wires under various names, such as "Weather-proof," "Fireproof," "Kerite," and "Bishop Gutta-percha," some of which have been used for a period of years. A new insulation called "Okonite," is announced September 6, 1884, as a promising compound.

A note in the ELECTRICAL REVIEW calls attention to the fact that the report for the month of October, 1884, shows that the number of Bell telephones returned during that month was in excess of the output. It is supposed that the Bell-Drawbaugh litigation caused the telephone companies to put forth but little effort to increase their business. During this year the use of "hard-drawn" copper wire in long-distance telephony was begun largely through the efforts of Mr. Thomas B. Doolittle, of the American Bell Telephone Company, and the enterprise of the Bridgeport Brass Company, the first manufacturer. The company began its experiments in 1882 and its wire was put in use in 1884.

Early in the year 1885 the advisability of organizing an association composed of the operating electric light companies of the country was discussed. The ELECTRICAL REVIEW assumed the responsibility of publishing a double-leaded editorial call-

ing a convention of these companies to be held at the Grand Pacific Hotel, Chicago, Ill., Wednesday, February 25, 1885. This move, curiously enough, elicited some opposition on the part of the manufacturing companies at first. The convention was attended by over one hundred delegates, and was called to order by Mr. William A. Hovey, associate editor of the ELECTRICAL REVIEW. Mr. J. Frank Morrison, of Baltimore, Md., was elected president; Mr. Edwin R. Weeks, of Kansas City, vice-president, and Mr. Hovey, secretary. The success of this important and influential organization is well known. It met semi-annually for several years and now meets annually, and is the occasion of the presentation of valuable and timely papers, and of highly important discussions relating to the electric lighting industry.

It will be observed that by this time there had been organized in the United States four representative associations, namely, the National Telephone Exchange Association, the New York Electrical Society, the American Institute of Electrical Engineers and the National Electric Light Association. Subsequent to this was the Railway Telegraph Superintendents' Association and the American Street Railway Association. The last named organization, however, did not have an electrical side to it until in the late eighties, after the electric railway had begun to replace horse power.

At the first electric light convention, in Chicago, the subjects proposed for discussion, many of which are of interest to-day, were the following:

1. Incandescent lights, particularly in regard to length of circuit upon which they can be run with profit.
2. Locating and avoiding crosses with telephone wires.
3. Power and its conversion into light.
4. Electric light globes and shades.
5. The best modes of connecting dynamos with power.
6. Electric lighting by water power.
7. Rates and rebates on electric lights by the year.
8. The use of electricity as applied to motors.
9. Where an electric-light system requires No. 6 conductor, is it desirable to use Nos. 6 and 4 in the same line?
10. Will armatures become affected by frost when exposed in transportation?
11. Special insulation or guards to insulation of lines at dangerous points and places.
12. Street lighting—the best manner and modes of accomplishment, embracing the location of lights and running of circuits.
13. Experience and results in the use of underground conductors.
14. Resolved, That the fireman should receive more pay than the engineer.
15. Help generally.
16. Experience of electric light companies in the use of copper-coated and uncoated carbons.

A letter from Mr. A. S. Hibbard, secretary of the Wisconsin Telephone Company, provoked a very lively discussion as to the respective rights of the electric light and telephone companies. For several years after this there was great rivalry between the companies operating in these two branches of the electrical field. To-day it is pleasant to record that they work in harmony, and the various electrical associations, heretofore named, have been influential in bringing about this state of affairs through personal acquaintance and the realization of the community of interests that existed.

A paragraph in the ELECTRICAL REVIEW of March 21, 1885, states that "somebody out West has knocked down the persimmon, and calls it the 'induction suppressor.' Another name suggested by a former showman now in the telephone business is 'extra territorial conversation facilitator.' However, with a long or short name, this is reported as coming into court to win."

In its issue of May 12, 1888, the ELECTRICAL REVIEW exclusively announced the details of the Tesla system of distribution and power transmission by means of the polyphase currents. The ELECTRICAL REVIEW said: "The system is based upon a novel principle, a continuous progressive rotation of the polarities of either or both elements (with armature or field magnet or magnets) of a motor by developing alternating currents in independent circuits, including the magnetizing coils of either or both elements, and as a modification of this shifting the poles of one element by alternating currents while magnetizing the other element by direct or continuous current."

One of the important events chronicled by the ELECTRICAL REVIEW with abundant illustrations and description was the opening of the long-distance telephone line between New York and Chicago, October 18,1892, just four days and four centuries after the discovery of America by Christopher Columbus. Mayor Grant, of New York city, conversed with Mayor Washburne, of Chicago; Professor Alexander Graham Bell, inventor of the telephone, was present in New York, as were also President John E. Hudson, of the American Telephone and Telegraph Company, and Vice-President E. J. Hall.

The opening of this line marked an important epoch in telephone history, and the success of the long-distance service in the telephone field is well known.

When the discovery of the Rœntgen rays was announced, the ELECTRICAL REVIEW presented almost exclusively the very valuable and interesting experiments relating to its discovery, with illustrations and data from the laboratories of Tesla, Edison and others. The interest taken in this subject, was shown by the very wide reproduction of these articles in the scientific and lay press of this country and Europe.

The developments in the technical and manufacturing branches of electricity are so well outlined on other pages of this issue that they need no further mention here. It, perhaps, will be of some interest to note the development and extension of electrical interests along the lines of the various electrical associations.

The Electric Club, of New York, was organized at a meeting held in the office of the ELECTRICAL REVIEW in 1886. Mr. Henry C. Davis was elected president and Mr. Charles W. Price, secretary. Other electric clubs were organized in Boston and Chicago, and for several years were successful and prosperous, and were the means of making acquainted with each other, probably more thoroughly than in any other way, the leading men of the electrical field. The Electric Club, of New York, had its first headquarters at the Hotel Dam and afterward a fine clubhouse on Twenty-second street was leased. On the occasion of the opening of the Electric Club, Professor Henry A. Rowland, of the Johns Hopkins University, delivered an address on "The Life and Work of Faraday." Mayor Abram S. Hewitt was present on the occasion of the opening of the club and delivered an eloquent address. He informed the earnest electrical gentlemen that they were the "couriers of the coming Millennium"—and at once Mr. Hewitt's large list of friends was greatly extended. The club continued its prosperous career until in the early nineties when interest became so diversified among the other clubs of the city that it was decided to close the clubhouse and the membership of the organization distributed itself among the other electrical societies of New York city.

The National Telephone Exchange Association, which was composed entirely of representatives of the companies licensed by the American Bell Telephone Company, held its final meeting at Detroit, in September, 1890.

The three electrical organizations in the United States that are general in their

character and prosperous and influential are the following:

American Institute of Electrical Engineers, New York—Mr. Charles P. Steinmetz, of Schenectady, N. Y., president, and Mr. Ralph W. Pope, of New York, secretary.

National Electric Light Association—Mr. Henry L. Dougherty, of Denver, Col., president, and Mr. George F. Porter, of New York, secretary.

American Street Railway Association—Mr. H. H. Vreeland, of New York, president, and Mr. Thomas C. Pennington, of Chicago, secretary.

The annual meetings of these associations are held in different cities.

The New York Electrical Society is a successful local organization. The American Institute of Electrical Engineers holds monthly meetings in New York and Chicago, and is the leading technical organization in the field of electricity, corresponding to similar technical organizations in London, Paris and Berlin.

The Independent Telephone Association of the United States of America is an association devoted to the telephone interests of the country outside the Bell telephone interests and meets annually in different cities. Judge James M. Thomas, of New York, is the president.

The ELECTRICAL REVIEW has been and will continue to be edited along earnest, conscientious and progressive lines. The field of endeavor is an interesting one, occupied by scientists and practicians of enterprise and ability, and is worthy the best efforts of those who chronicle its development. CHARLES W. PRICE.

Twenty Years of Electrical Development.

A Chapter in Industrial Evolution—1882 to 1902.

By Charles T. Child.

WHEN THE passing of the nineteenth century gave occasion for the summation of achievement in various directions and the review of progress of the industrial arts during that time, two facts of the first importance stood out prominently: The first was that the application of electricity had become the largest and most potential factor in shaping the immediate processes of evolution; the second was that the effective history of electricity as a factor in industry had been crowded and compressed into the last quarter of the passing century. Indeed, it could fairly have been said that the last twenty years had seen the great bulk of electrical development.

In looking over the progress of this subject for the period of time covered by the life of the ELECTRICAL REVIEW, the most notable phase of the industrial application of electricity is certainly its immense extent. But scarcely less interesting than the magnitude and vigor of growth of the industry is the curious interrelation between its various branches, and between electrical application and the general welfare of mankind. Aside from its directly practical and visible results, the conquest of electricity as a means of civilization has stimulated and vitalized all of the evolutionary forces which are at work shaping the general destiny and the general future.

In 1882 the telegraph, which was the first of the important practical applications of electricity, had become a thoroughly understood and completely worked-out industry. Its extension had been for some time normal and no revolutionary invention or application, save the invention of multiplex telegraphy, had been made in the subject since the laying of the Atlantic cables, thirty years before. The telephone was being discovered industrially. It had been introduced in a number of cities and towns, the exchange system of operation had been devised and the telephone had been perfected by the invention of the battery transmitter. Electric lighting was confined to arc lighting, a number of "systems" being in the market. Incandescent lighting was just being introduced, while the electric railway and all of the industrial applications of electrochemistry were as yet for the most part in the laboratory stage.

At this period the United States had recovered from the industrial shock of the great Civil War, the West had been opened and the period of expansion which marked the flow of population into the central and western portions of the national domain was begun. It was a time for new things; a time when capital sought investment in channels promising large returns, and when some of the traditional conservatism which marks large investors seemed missing. It was distinctly a time fit for the introduction of great new enterprises and for the production of novel ideas.

The electric light had come to us from France and Germany. Its first really industrial development—its first reduction to practice—was due, however, to the genius of an American who devised one of the most simple, satisfactory and direct pieces of mechanism possible to replace the clumsy and complicated arc lamps of Duboscq and Fresnel—Mr. Charles F. Brush. Mr. Brush devised a type of dynamo machine admirably suited for the purposes for which it was intended, and with his comparatively simple lamps began the work of making a place for the electric light in competition with gas and other illuminants.

It was a day of "systems." Every inventor produced an entire set of apparatus for electric lighting, including dynamos, regulators and lamps, and it was not long before half a dozen rival systems were competing for the enormous business which it seemed must follow the commercial introduction of electric lighting.

Two factors combined to make the introduction of the electric light rapid and widespread. One of them was the curiosity which is a trait of American character and which demands continually to see a new thing. The other was the rivalry of the various systems and inventors—a condition which in a stable art would be regarded as an economic mistake, but which, in an embryonic industry, is actually helpful. Discussion was promoted, prices were brought down to reasonable points, and the commercial travelers representing the various manufacturers acted not only as agents for their respective wares, but also as missionaries enlightening both the physical and intellectual darkness of the people.

The names of the men who laid the foundation of this great industry were generally given to the systems they devised. There was the Thomson-Houston, the Wallace-Farmer, the Weston, the Hochhausen, Schuyler, Fuller and others.

The telephone in 1882 had already had four years of commercial exploitation and had been very considerably perfected. Battery transmitters were in general use,

the exchange system had been very widely introduced and the multiple switchboard had been invented. Practically all telephone circuits were of the grounded variety and the distance over which conversation was conveniently practical was limited both by the exigencies of the transmitters employed and the poor talking quality of the circuits then in general use. The telephone, however, had demonstrated its usefulness and had already enlisted the confidence of the business community. Extensions of telephone systems were going on everywhere and exchanges were being installed in all of the larger towns and cities.

The streets of a great city of that period were literally darkened with wires. While cables for submarine purposes were well known and had been manufactured for many years, satisfactory cables for underground use in cities had not been commercially developed nor had the conduit system been perfected.

The application of electricity to chemistry and the chemical arts was almost entirely limited to electroplating and electrotyping. Both of these arts had been developed years before and already enjoyed some industrial significance, large sums being invested in the manufacture of plated silverware, and electrotyping being a well-recognized branch of the printing art. The electric furnace was not known, or at least had been used only to a very limited extent in the laboratory, while the larger applications of current to metallurgical problems were still entirely undeveloped.

The year 1882, however, will remain forever memorable in the annals of electrical development on account of the opening in New York, on September 4, of the first incandescent lighting central station in the world. The idea of the incandescent lamp had been slowly developing itself in the minds of inventors in many parts of the world. It remained for an American, uniting with extraordinary ingenuity and ability a remarkable sagacity and foresight, to perfect almost at one step the incandescent lamp and the method of its commercial use.

Probably of all of the great work that he has done for the extension of the electrical arts, Mr. Edison's invention of the central station is his greatest. Having worked out to his satisfaction the method of operating these lamps upon parallel circuits, and conceived the idea of public supply of electric light from a central station, he set to work to carry out the details of his invention and to put into practical effect the new idea. New York city was the chosen field, and in the work leading up to the installation of the old central station in Pearl street was developed another of the conditions which were shortly to become prominent, and a solution for a problem which was soon to become one of paramount importance and difficulty.

In planning the circuits for distributing electric light and power it became evident to Mr. Edison and his associates that the copper conductors necessary would be of a size such as had certainly never been used before for electrical purposes. It was practically out of the question to support the massive cables on poles overhead and, as a detail of the station distribution system, it became necessary to devise and perfect an underground system of distribution. The system devised is still in use in many important installations and is known as the Edison tube. The greatest difficulty was met at this time in finding proper engines to drive the dynamos, as considerations of space required the machinery to be direct-coupled and consequently that the engines should run at high speed. The immediate effect of building this station was immensely to stimulate the art of engine building and to bring out the prototype of a new species of engine adopted for high-speed running.

We may then, as it were, look at general conditions of the electric art twenty years ago. The Edison station had just been constructed and was furnishing incandescent light over a considerable area of New York city. A large number of arc light stations were running in various cities of the country, the electric arc having become recognized as the best illuminant for streets and open spaces. The largest machines employed in this variety of lighting, however, were capable of maintaining only sixteen or eighteen lights each. Experiments had been begun by Mr. Edison, at Menlo Park, on the electric railway, using for the first time current supplied by a dynamo machine. The historical labors of Davidson in Scotland, of Professor Page and Moses G. Farmer in this country had almost been forgotten, and the apparatus employed was of the crudest type. At the same time other timid advances were being made which were destined to become the foundations of great arts. In the United States the refining of copper by electrolysis had just been begun. In England Dr. William Crookes was conducting the magnificent series of researches on vacuum tubes which was later to lead the way to the discovery of the X-rays, and in France, Plantè had just exhibited for the first time the storage battery before a meeting of the Acadèmie Française.

The telephone and the telegraph represented the well-founded electrical industries. There were in use 180,592 telephones in January, 1882, in the United States and Canada. While the building of long-distance lines had not begun, and telephones were mostly operated on grounded circuits, still the art of telephony had reached a point of considerable development and the telephone was already fully recognized as an important and valuable adjunct of business. The telegraph had been very highly perfected. A number of cables were satisfactorily working across the Atlantic, and both duplex and quadruplex telegraphy had been introduced with their attendant economies and improvements. It was a period of development, of outgrowth and of brilliant achievement such as no other art has ever seen.

Let us now trace the development to its present advanced condition and note the influence of the various factors which worked together to produce the results with which we are familiar to-day.

Early in the next year the firm of Siemens Brothers in Germany undertook definitely to construct an electric railway for actual passenger service at the Giants' Causeway in the north of Ireland. It is interesting to note that the equipment of this line, which was several miles in length, was with the third-rail system of conduction. Power was derived from a cascade on the Rush River near-by, and from the beginning the enterprise was a commercial as well as an engineering success. In the United States the consolidation of the antagonistic interests of Field and Edison resulted in a vigorous undertaking to build electric railways, and at the railway exposition held in Chicago in 1883 an electric locomotive was exhibited. During the same year Mr. Leo Daft constructed his first electric railway at Mount McGregor, near Saratoga Springs. Attention of those who were working on the frontier of electrical development was diverted by these important achievements to the problem of electrical transportation, and the year 1884 found this subject rapidly coming to the front as one of immediate and considerable importance. During that year several notable developments took place. Among these, and one that can not be counted the least important, was the formation of the American Institute of Electrical Engineers. During the summer there was held at Philadelphia, under the auspices of the Franklin Institute, an electrical exhibition

and in connection with it was held a national conference of electricians, authorized by Act of Congress and attended by some of the most eminent living scientists. These meetings were the birthplace of the Institute. The influence which has been exerted upon the development of American electrical affairs by the work of the Institute can hardly be exaggerated. At its meetings have been announced some of the greatest advances of the art of electrical engineering, and among its members are numbered those who more than any other men have contributed to the general progress of civilization during the last two decades.

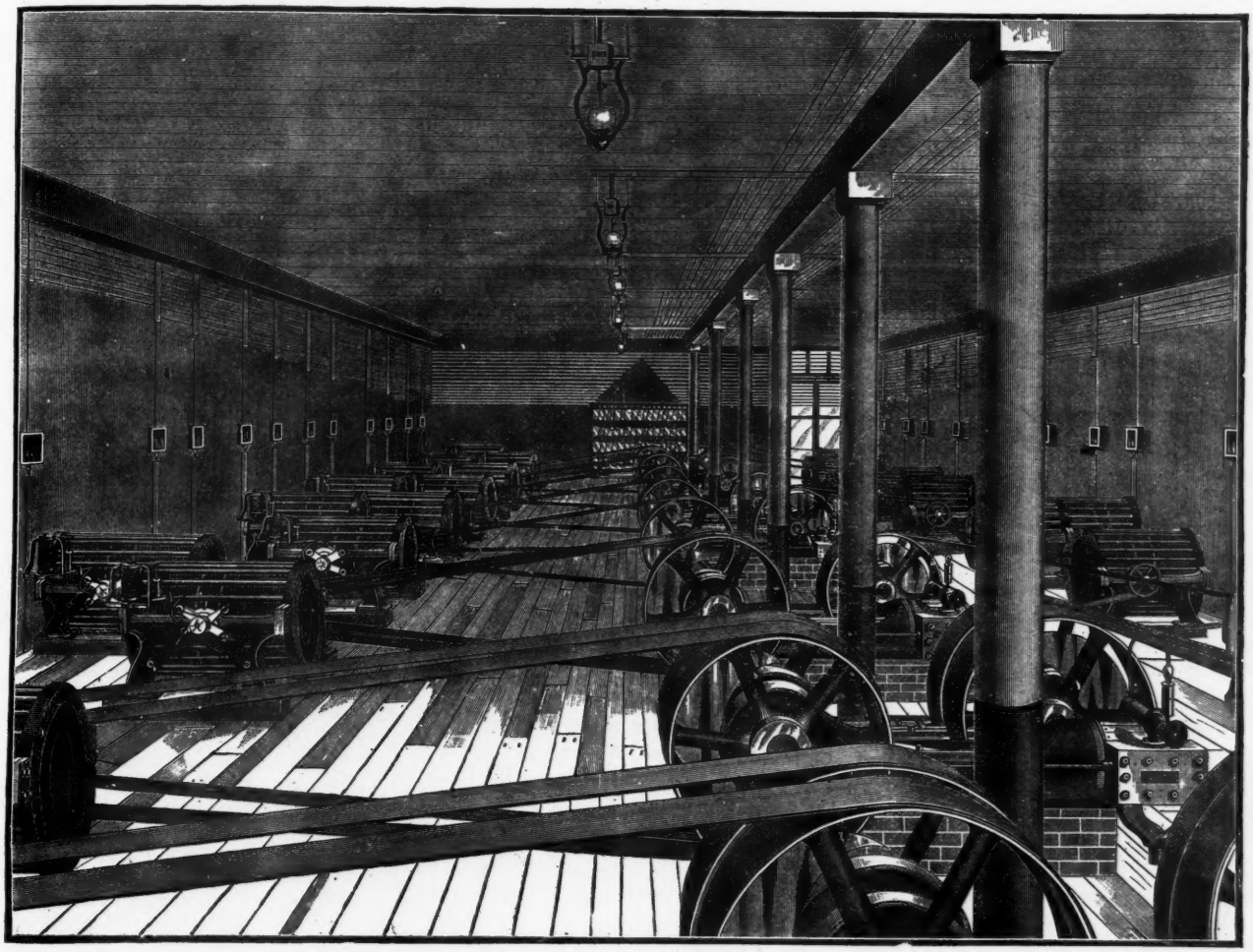
It was during the same year that the Siemens Brothers built in Germany an electric railway between Berlin and Charlottenburg, which enjoys the distinction of being the first line on which horses were superseded by the electric motor. Another development during the same period, far in advance of its time, was the construction in Cleveland, Ohio, by Messrs. Bentley and Knight of an electric railway on the open-slot conduit system which contained all of the features of the railroads now in use in New York and Washington. Toward the end of the year came the most important advance that had been made, in the opening of the first overhead trolley line in the world at Kansas City, Mo. This road was built upon the designs of Mr. J. C. Henry.

By the close of this year interest in the electric railway was widespread. Already companies operating horse-car lines in various cities were seriously considering the question of electrical equipment and a number of tentative experiments were being conducted in various parts of the country. The electric light was developing with great rapidity. A considerable number of systems for arc lighting were in full commercial use and the incandescent light was rapidly being extended along the lines laid down by the original installations of the Edison companies.

The next year, 1885, witnessed the formation of the National Electric Light Association, an organization of persons interested in the commercial development of electric lighting and one which has accomplished untold good for that industry. It is interesting to note that during the same year the storage battery was for the first time installed as an adjunct to an electric lighting plant in the station at Philipsburg, Pa.

Perhaps, however, the most significant advance made during the year in the field of electric lighting was the formation of the Westinghouse Electric and Manufacturing Company as an outgrowth of the United States Electric Light Company. With the advent of this concern was introduced for the first time in America alternating current for electric lighting. To Mr. William Stanley belongs the credit for having designed the first commercial system for this purpose, including generators and transformers.

What seemed to be an almost irrepressible conflict immediately broke out between the advocates of direct and alternating current for electric lighting. Out of the discussion thus precipitated came many good results, not the least of them being the general education of the public in re-



THE STATION OF THE MERCHANTS' ELECTRIC LIGHT AND POWER COMPANY, BOSTON, MASS.
Reproduced from the ELECTRICAL REVIEW of March 27, 1884.

gard to electric light and its applications. The year's advance was further marked by the construction in Baltimore of a third-rail railway system and by the building, in Toronto, Ontario, of a line of electric railway employing the underrunning trolley. It was during the same year, before a meeting of the American Institute of Electrical Engineers, that Lieutenant Frank J. Sprague read his classical paper on the electrical equipment of the elevated railroads in New York city.

The next year, 1886, saw a still further development in the direction of commercializing the electric light. By this time arc lighting of streets had become common and in some respects even standardized. It had been found out that the older systems employing very large current with short arcs were not economical in practice, and installations using currents of about 6.5 amperes or ten amperes had virtually become standard. The telephone was coming further and further into touch with the business community and the work of putting wires underground in great cities was progressing with, however, considerable friction between municipal authorities and the managements of electricity supply companies. The most notable events of the year were the experiments inaugurated on the lines of the elevated railroads in New York by Mr. Sprague looking to the future development of an electric traction system for that important avenue of communication. These experiments foreshadowed much that has since been accomplished. Successful runs were made with trains equipped with motors mounted on the trucks on one of the divisions of the elevated railroads but, like other promising and important pieces of experimental work done during this stage of electrical development, nothing immediate came of it because the work was too far in advance of the immediate requirements of its time.

In the next year, however, there was completed, in the face of almost insurmountable difficulties, a work of electrical engineering which laid the foundation for one of the greatest industries that has been developed in connection with the electrical arts. At Richmond, Va., it was decided to construct and equip with electricity a street railroad of large size having nearly fourteen miles of track and operating fifty cars. The road included grades of more than ten per cent, many sharp curves, and was altogether about as difficult a piece of railway for equipment as could be found. Upon the work of constructing these lines and their equipment Mr. Sprague and his associates, both engineering and financial, entered with the enthusiasm born of implicit belief in the outcome of their undertaking. In the autumn of 1887 the road was completed and its trial exhibited that the equipment, barring those minor details which could be perfected only by experience, was an astonishing commercial and engineering success. The outcome of this success was one of the most extraordinary developments that has marked the industrial history of the world. It may truthfully be said that in 1887 there was only one first-class electric railway in existence—the road at Richmond. To-day, with only fifteen years of development, there are in the United States alone more than one thousand electric railway systems of all classes and sizes, representing a total investment of more than two billion dollars, giving employment to several hundred thousand people, and exerting daily an influence upon social and economical conditions as great as that of any other single agency at present at work.

It may be well here to turn aside for a moment and note the nature of the influence that the electric railway has exerted both upon society at large and the general configuration of the country. Before the advent of this satisfactory local transportation agency there was a noticeable tendency for cities to crowd together, a tendency toward condensation. Against this was arrayed every consideration of public health and personal convenience. In the larger cities slum districts grew up in the neighborhood of manufacturing and other works employing large numbers of people and, perforce, the distance between a man's place of work and place of residence could not be large. He must either walk to his work or travel in the slow and unsatisfactory horse car.

The coming of the trolley released at once the centrifugal tendency of city populations and began to accomplish the distribution of people, away from the crowded districts in which they were herded close to their work into the more healthful and generally better surroundings of the suburbs and the country. It has been recognized from the time the electric light was introduced that as an agent for the prevention of crime, illumination was working wonders; to quote an eminent authority on such matters, "one arc light was quite as good as two policemen." But the moral effect of the trolley road was even greater than that of the arc light. By permitting population to disperse, by allowing families to grow up in more sanitary and reasonable conditions than had formerly surrounded them, an immense work for the general social betterment was accomplished in a most unlooked for and efficient way.

Beyond this, certain other singular results flowed out of the general extension of street-railway systems. Cities began to grow, not only as they had grown in the past by the influx of population, but by a material expansion of their limits into and inclusive of the surrounding country. Brooklyn, through the agency of the trolley, grew from a small town to a city of over a million inhabitants. Chicago reached out from its crowded situation on the shore of the Lake and the banks of the Chicago River to take in an enormous area of tributary suburbs, and in the Middle West especially, as perhaps less noticeably in New England, suburbs reached out from towns until they met and formed continuous inhabitated areas through which the connecting link of the trolley road ran, thus forming the basis of a new network of transportation systems destined soon to become a formidable rival of the existing steam railroads in transporting passengers.

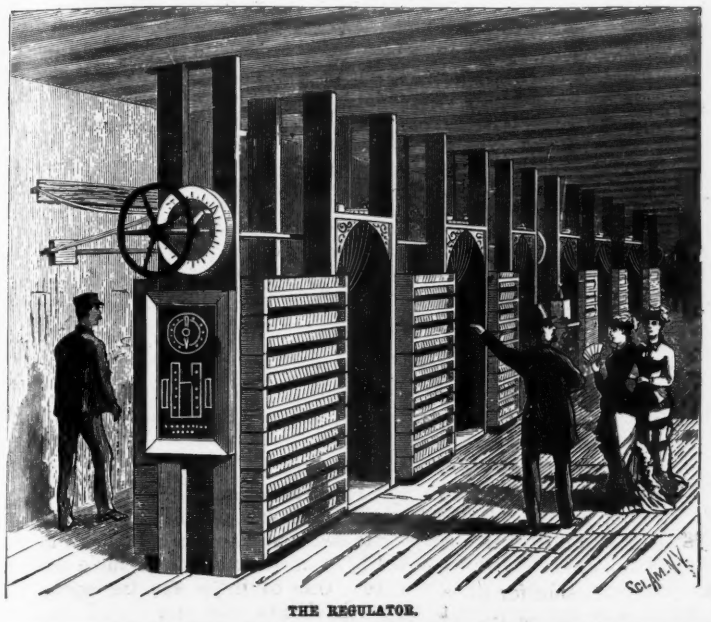
Coming back now to the orderly progress of events, we find the year 1888 to be marked by two events of considerable significance. One of these was the operation, on the Ninth avenue elevated railroad in New York, of an electric locomotive, designed by Mr. Leo Daft, and exhibiting for the first time in the annals of railroading power sufficient to propel a heavily loaded train of six cars at speeds in excess of forty miles an hour. The other event of the year was the announcement, before a meeting of the American Institute of Electrical Engineers, of the invention by Mr. Nikola Tesla of motors which could be operated by systems of alternating currents working together to constitute what is named to-day the polyphase system.

The condition of electrical engineering at this time was such that this epoch-marking innovation was immediately understood and its immense significance was grasped. The problem of power transmission had begun to interest electricians everywhere. It was evident that there might be, in the outgrowth of electric motor devices, some method of transmitting power to considerable distances without wasteful loss, and that such a method developed would have a very vital industrial influence. Indeed, engineers had waited for some time for such a system. While the direct-current central stations, operating motors upon the same mains from which their lamps were burned, had shown an example of what was possible in electrical transmission, and while a few factories had been equipped with electric motors and circuits to replace shafting and belts, still no method was known which would permit the transmission of considerable powers to long distances. This was supplied by the new designs, and the next year, 1889, discovered a commission of engineers studying the conditions surrounding the development of power at Niagara Falls with a view to its ultimate transmission to Buffalo and other adjacent towns and cities.

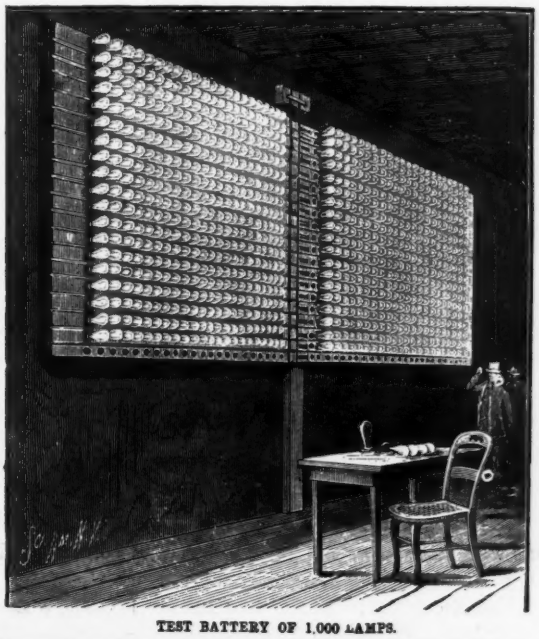
The same year also witnessed the be-

ginning of a series of industrial combinations destined to lay the foundation for powerful corporations which would subsequently nandle the bulk of the electrical business of the country. In that year the Thomson-Houston Company took over the Brush Electric Light Company and thus began a series of consolidations which eventuated finally in the formation of the General Electric Company, the most powerful manufacturing corporation in the field of the electric arts.

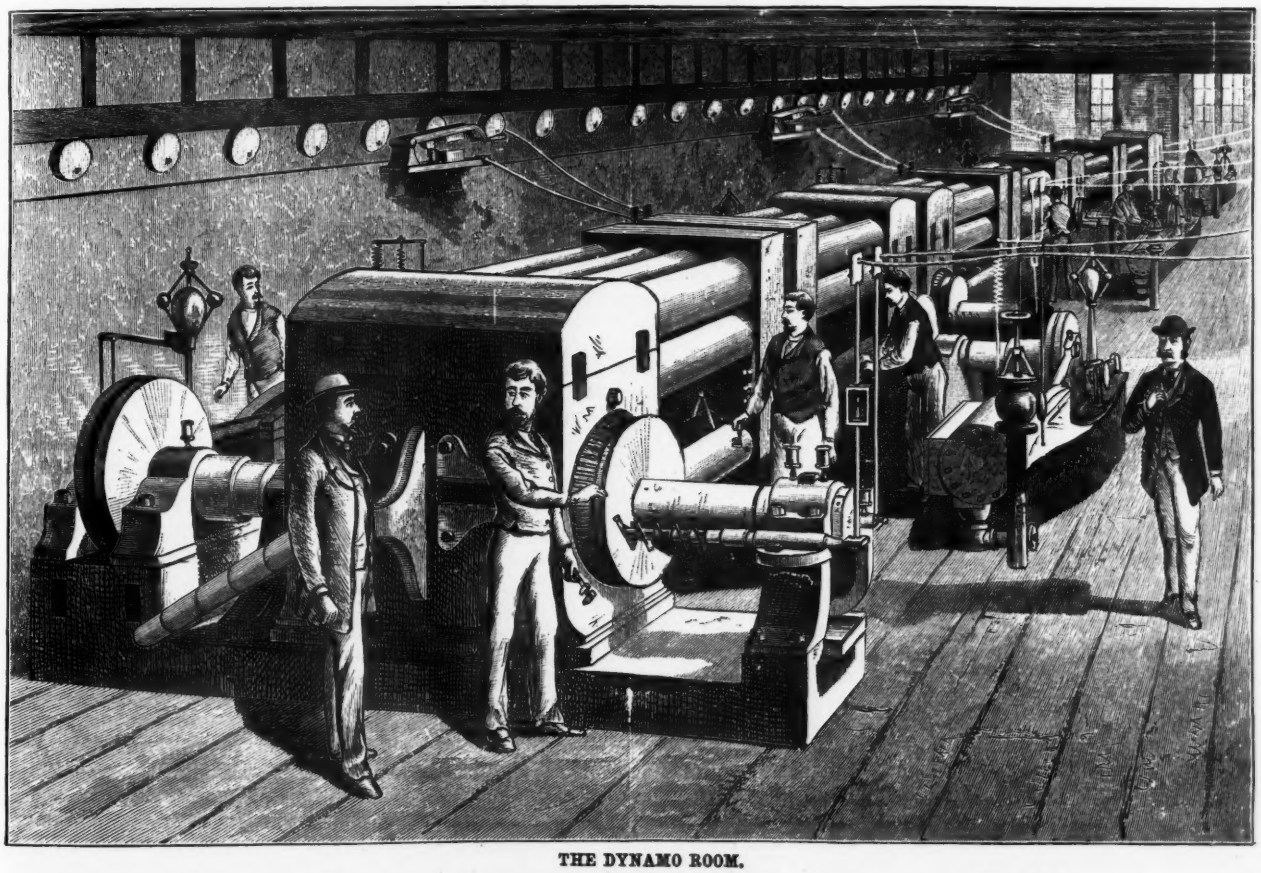
The years 1889 and 1890 were marked by a tremendous development of the electric railway and by the continued growth of electric lighting systems. There was no spectacular advance in either of these years, and not until 1891 was it attempted seriously to transmit power commercially by electricity to long distances. In this year a company in California undertook, by means of direct-current working up to pressures in the neighborhood of 10,000 volts, to transmit power for some distance into San Francisco, but the project failed through lack of proper financial support. The next year the long-distance transmis-



THE REGULATOR.



TEST BATTERY OF 1,000 LAMPS.



THE DYNAMO ROOM.

VIEWS IN THE FIRST CENTRAL STATION—THE EDISON PEARL STREET STATION IN NEW YORK CITY.

Reproduced from the *Scientific American* for August 26, 1882, by courtesy of Messrs. Munn & Co., New York.

sion at Pomona, Cal., was inaugurated, this being the first industrial use of polyphase currents for power transmission work. In the same year the General Electric Company was formed, and, in another branch, the first steps of a movement destined to become important were made. This latter was the organization of telephone companies independent of the parent Bell telephone corporation and its licensees. In this year the enclosed arc lamp was invented, the greatest improvement in arc lighting that has been made since the original clutch lamps were produced.

The year, 1893, of the World's Fair at Chicago was one of much electrical progress. The fact of the exposition itself was sufficient to draw forth all the efforts of manufacturers of electrical apparatus, and at the exposition many extraordinary novelties were shown. The development of the electric railroad was admirably illustrated by an elevated railway, electrically operated, which encircled the grounds of the exposition, while apparatus of a magnitude hitherto unthought of was exhibited. The same year witnessed the expiration of the fundamental patent issued to Professor A. G. Bell for the electric telephone, and in this way opened the industry of telephone manufacture to outside makers not connected with the important corporation which had by that time grown up for the exploitation of the telephone. An event of further significance was the closing of contracts for the electrical equipment of the Niagara Falls power plant, then much the largest generating station that had ever been designed, the contract including dynamos of a size such as had never been conceived before and a transmission of a large total horse-power to Buffalo, twenty-seven miles distant.

Modern electrical engineering may be said to date from the Chicago exposition and from the inception of the plans for the Niagara Falls plant. Since that date progress has been steady and certain, but the spectacular achievements made in the ten preceding years have not been equaled by any direct invention made since then. The electric railway had been completely developed, the telephone had been extended so that long-distance lines were in operation between Boston and Chicago, and electric lighting, both arc and incandescent, had reached a point of high perfection and was very generally introduced throughout the country. Electrical engineering had entered upon a period of general and steady advance, and the electrical industries began by this time to take their place alongside of other and older manufacturing interests as an important part of the stable and settled industrial equipment of the country.

In 1894 an exhibition of vacuum tube lighting was given by Mr. D. Macfarlan Moore before the American Institute of Electrical Engineers. The next year saw two interesting departures in electric traction. At Washington an extensive system of open-slot conduit electric railway was installed with remarkable success, and the long tunnel constructed by the Baltimore & Ohio Railroad Company under the city of Baltimore was equipped with electric locomotives, each weighing ninety-six tons and capable of hauling a heavy freight train with its engine through the tunnel at high speed. It was in this year that the announcement, at first regarded with no little incredulity, came from Germany that Dr. Rœntgen had discovered a mysterious radiation capable of penetrating the human body and many other substances. It was little thought then that within five years this discovery would result in appliances of the utmost value in surgery, and would find use not only in sick rooms and hospitals, but on battle-fields scattered over half the world.

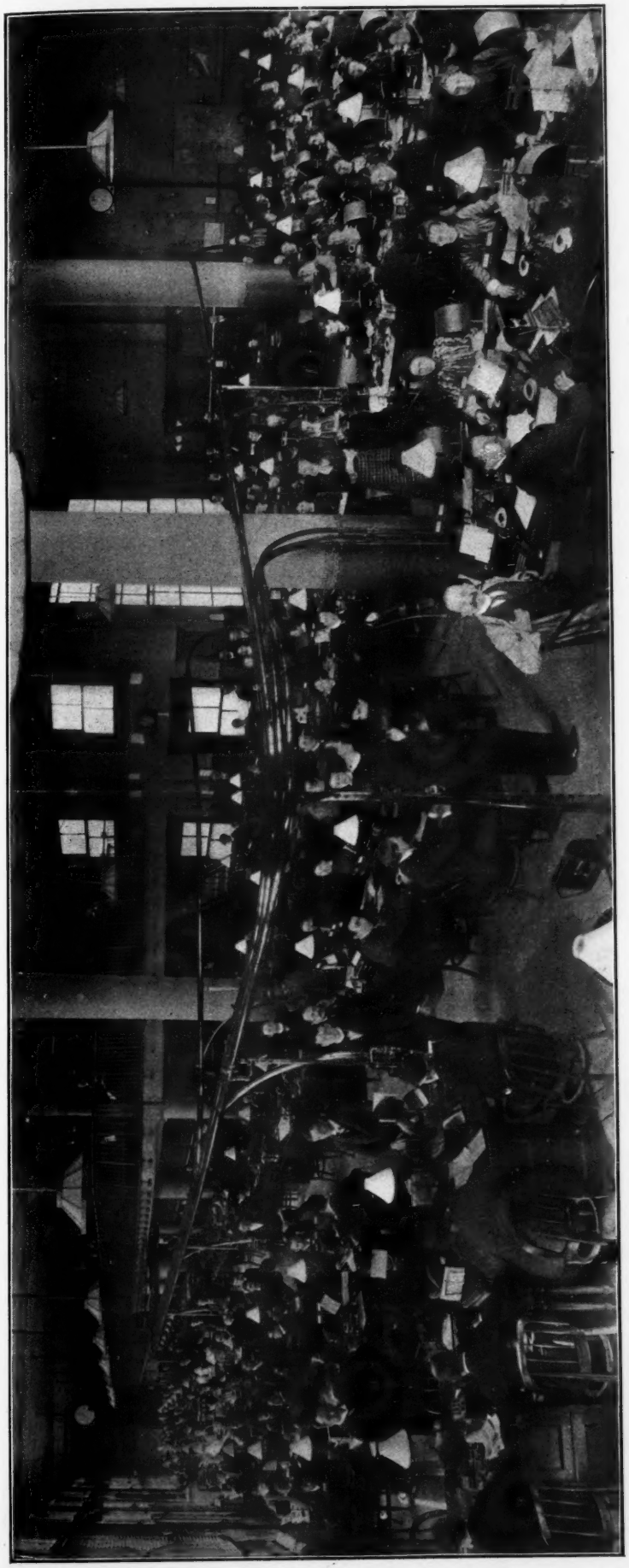
In this year, 1895, the Niagara Falls power plant was first set to work, and as an immediate consequence a number of industries using electric power, either directly for the production of mechanical power or as an assistant in various chemical industries, were started near-by. Among them were two exceedingly interesting applications of the electric furnace. Two years before M. Henri Moissan, in Paris, had done some remarkable work with the electric furnace and had succeeded in producing enormous temperatures and through their action had made for the first time a number of novel substances. An accidental discovery led to the foundation of a large industry for the manufacture of one of these products—calcium carbide. Great works were established at Niagara Falls for the manufacture of this substance, of which large quantities are used for the production of acetylene gas and the enrichment of ordinary illuminating gas. It was also discovered that in the fervent heat of the electric furnace sand and coke could be melted together to form a jewel-like substance only a little less hard than the diamond and of great value in the arts. To Niagara also came industries of chemical manufacture, the production of bleaching powder and caustic alkali and, perhaps of greatest interest to electricians, the manufacture of aluminum.

The power of the cataract was transmitted successfully to Buffalo and there put to work both for lighting the city and for running its street cars, as well as for a variety of other uses. Boats laden with grain and coal from the upper lakes were discharged of their cargoes by the force of the falling waters of Niagara, thirty miles away. The extraordinary success of this power-transmission system was an incentive for the establishment of others in various parts of the country, and almost immediately after the commercial feasibility of the method had been demonstrated and practised plants for power transmission were installed in all directions. The western states, with their high mountain ranges and numerous cataracts, were stocked with minerals and other raw materials of manufacture, but not being provided with coal were in a difficult position for the establishment of manufacturing industries. Electrical transmission solved the difficulty and gave them abundant power at low cost. Further than this, the same work necessary for the control of the waters of mountain streams for use in developing power were also largely useful in distributing the water, after it had done its work in turning the wheels of the power stations, to irrigating ditches, thus causing desert regions to become productive and enabled to sustain the increasing population called in by the new industries growing up around the power plants.

By the summer of 1896 the independent telephone movement, which had begun at the time of the expiration of the Bell telephone patents, had assumed considerable proportions and a society known as the Independent Telephone Association of the United States was formed to foster the work of this class of telephone exchanges. About the same time the announcement came from across the water that Mr. G. Marconi had succeeded in telegraphing short distances without wires, making use of the familiar results of Hertz's experiments.

From this time up to the present it is hardly necessary to recount the history of electrical development with which all who read this are probably familiar. In 1897 considerable installations for electric traction on a large scale were laid down by the New York, New Haven & Hartford Railroad and electric cabs came to be a familiar feature of our city streets. The next year the cable service of the Brooklyn Bridge was replaced by an electric service, and in Europe important plants utilizing polyphase current for direct railway traction were established. Since that time development has been most extensive, but doubtless much that has been done still suffers from the impossibility of justly understanding the effect and bearing of contemporary performance. In the summer of 1900 Dr. Pupin laid before the American Institute of Electrical Engineers the results of his analytical labors concerning the betterment of telephone circuits. The following spring, before the same body, Mr. Edison announced his new type of storage battery. Last summer a power transmission in California, working at 60,000 volts, succeeded in the commercial transmission of power 225 miles across the state. In December, just past, Mr. Marconi successfully signaled across the Atlantic Ocean by means of his wireless telegraphy system. During the summer, at the Pan-American Exposition in Buffalo, the most beautiful and extensive illumination by incandescent lamps ever undertaken was operated by power from Niagara, twenty-five miles distant.

As we look back at the development of electrical engineering and the application of electricity to the affairs of everyday life, we are struck, perhaps, most by the enormous extent to which these applications enter our daily affairs. Twenty years ago the telephone was still largely a curiosity, the electric light had only been seen by a small proportion of the population, and the electric railway existed only in the minds of a number of advanced thinkers.



THE OPERATING ROOM OF THE MAIN OFFICE OF THE POSTAL TELEGRAPH COMPANY IN NEW YORK CITY.

The Operating Room of the Postal Telegraph Company in New York City.

When, twenty years ago, the ELECTRICAL REVIEW was founded, the telegraph was the only fully established electrical industry. Electric lighting had just begun, and the telephone was in the inchoate stage preceding its fuller commercial development. The telegraph office of that day, though, was a thing of main-line and local batteries—a vast congregation of glass jars and bluestone. How different it is to-day may be judged from the illustration here shown of the main operating room of the Postal Telegraph Company in New York city.

This operating room occupies a floor of the fine office building bearing the company's name. A working force, divided into three shifts for night and day service, aggregates some four hundred and fifty men and women, three hundred and fifty of whom are regular operators, the balance being made up of clerks, chief operators and special workers.

An average total of fifty thousand messages per day is handled on the two hundred and twenty-five instruments. Of this number, forty are on duplex circuits and fifty on quadruplex circuits, the rest being simple single Morse circuits. At some periods all of these instruments are working simultaneously, and in addition to this about one hundred independent circuits from the Stock Exchange and brokers' offices in different parts of the city pass through this office.

An elaborate system of checking and filing is carried out in the large gallery, situated in the centre of the main floor. As the messages are transmitted, the blanks are pigeon-holed in alphabetical order, and should any question arise necessitating research this is accomplished with a minimum loss of time.

Current is supplied by means of twenty-three Crocker-Wheeler motor-dynamos with a total output on the secondary side of about one hundred amperes at forty volts, seventy-five per cent of which is used for the local circuits. These machines are handled as units of battery were formerly handled, plugged into series for long lines, etc.

The policy of the company, as represented in the management of the operating department by its manager, Mr. Charles Shirley, is one of great liberality, and many improvements, both in service and in operating conditions, are due to long investigation from practical viewpoints.

The fastest circuits are operated on a

piece system, notably the through lines between Boston, Philadelphia, Buffalo, Chicago, St. Louis, Pittsburgh and San Francisco. The operators on these circuits are expected to send a minimum of two hundred and eighty messages per day, for which they receive a stated salary. For each message in excess of two hundred and eighty a bonus of one cent is awarded, which brings the daily compensation of these operators considerably above that of the average artisan.

Another important innovation is the "Morsegraph," the creation of Mr. J. F. Skirrows, assistant manager of the operating department, and Mr. Shirley. As its name signifies, this instrument "writes Morse." A series of circuits is connected with a printing apparatus, and upon an endless tape a faithful record in dots and dashes is kept, in parallel lines, on both sides of the paper, the whole series up to as many as twenty-four circuits, printing at one time, each synchronously with its appropriate sender, no matter where the latter may be situated. In case of errors being discovered, this record may be immediately consulted, correction made and identification secured.

A careful research as to the causes and probable remedy for "operators' paralysis," by Mr. Shirley, has led to the invention and introduction of a new form of sending apparatus. This provides a leverage medium of contact and is mounted upon a metal base so that it may be operated in any position. The lever is capable of indefinite adjustment and the concentration and rigid movements of the old key entirely obviated. This has not only been a success from a material standpoint, as on long lines the more regular and cleaner work of this instrument has been made manifest, but has achieved remarkable results in a most desirable direction. By bringing a new and vigorous set of muscles into use, otherwise capable men, who, under ordinary conditions would have to be discarded because of breaking down, have been practically redeemed and are now operating on some of the fastest circuits.

The Largest Double-Current Machine.

The Great Direct and Alternating-Current Generator in the Chicago Edison Company's Station.

WHEN electric lighting from central stations was first practised only direct current was distributed, but it was not long before the alternating current was introduced in this country and plants of considerable magnitude were established to distribute it for general purposes of illumination. At Chicago, a city whose territorial area is very great, there were originally established a considerable number of independent lighting corporations, each operating within its own territory, some of them being direct-current systems, while some found alternating current more advantageous.

When the Chicago Edison Company removed its main station from the building formerly occupied, in Adams street, to the fine new station on the banks of the Chicago River at the crossing of Harrison street, it was decided to adopt, at least in part, a system of current generation which would permit the feeding of the widely scattered areas and districts embraced in the enormous extent of the company's operations. For this purpose it was evidently necessary to have recourse to some form of high-tension distributing system which would permit the installation of substations at various points, and from them the feeding of adjacent areas. In order best to accomplish this purpose it was decided to lay down a network of high-tension feeders and employ three-phase current at high pressures. In considering the question of generating directly this current for distribution it was found that on account of the distribution of lighting and of motor loads in Chicago —the business section of that city has probably the most extensive motor service anywhere to be found — considerable betterment of the general output conditions could be had by the use of double-current machines.

A double-current machine is precisely similar to a rotary converter and consists of a dynamo, generating direct current at any desired voltage, and having its armature windings tapped at convenient points and connected with collector rings so that polyphase current may also be taken off. A number of these machines were included in the original equipment of the Harrison street station, and it was recently decided to install a double-current machine of gigantic dimensions which might largely take the evening load of the business district as well as supply current to outlying suburbs such as Hyde Park, North Chicago and the West Madison street substation.

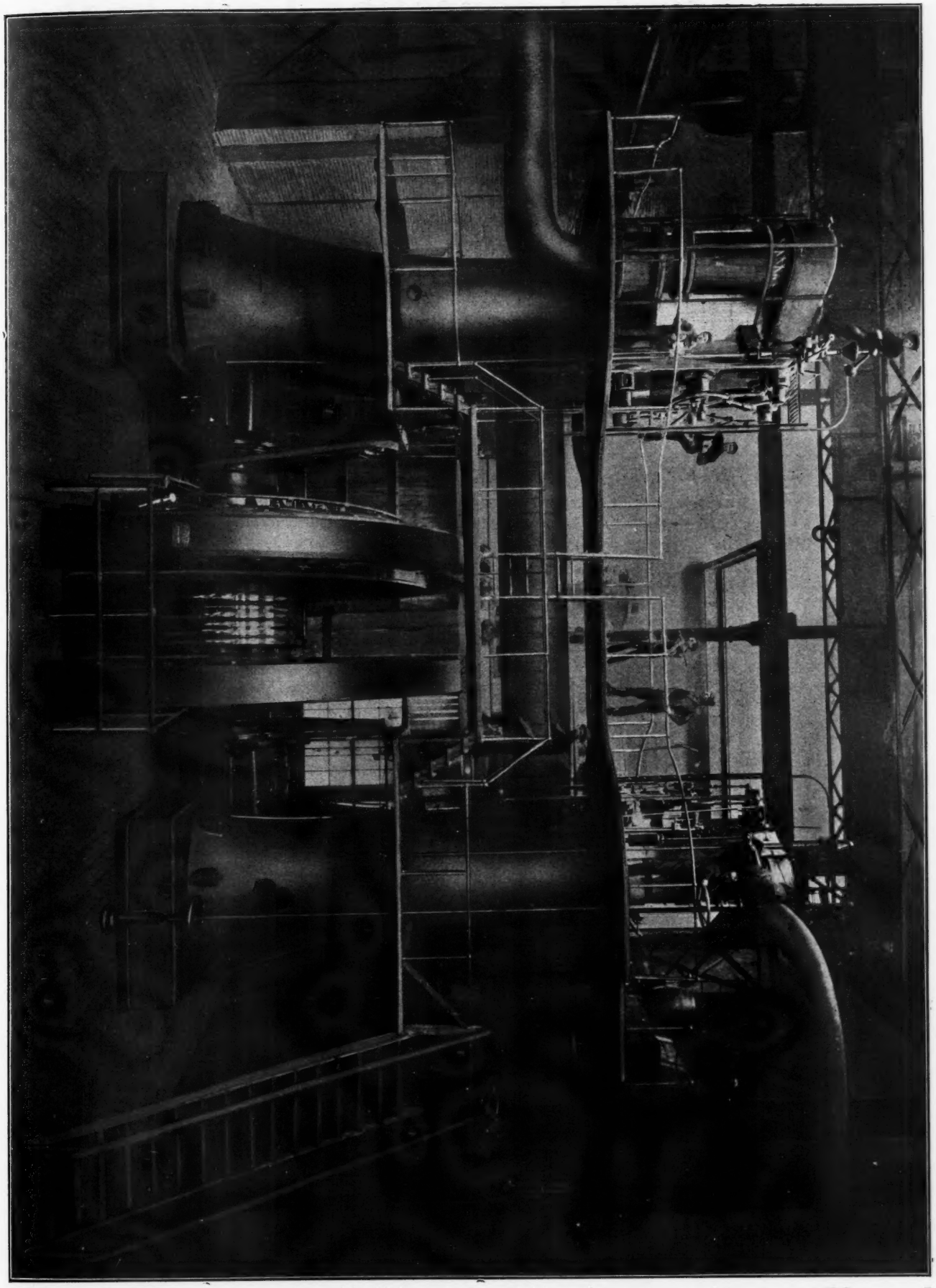
On the opposite page is an illustration of the machine that was installed to meet this demand. It is very much the largest double-current machine ever built, and consists of a General Electric Company's generator mounted on the middle shaft of a vertical cross-compound Allis engine. The engine is rated for a maximum output of 5,000 horse-power, while the dynamo is rated for a three-hour maximum output of 3,200 kilowatts. The machine is wound to give 300 volts on the direct-current side, this feeding directly into the outside of the general three-wire distribution system employed in the business district of the city south of the main branch of the Chicago River. On the alternating-current side, six-phase alternating current at twenty-five cycles per second is taken off and properly transformed in voltage by a battery of stationary transformers in the station.

The armature of this immense machine is twenty-one feet eight inches in diameter, and, necessarily from the design of this type of machine, rotates. The commutator is no less than fifteen feet in diameter and is composed of 960 hard-drawn copper bars. Upon this immense commutator rests 560 brushes, arranged in forty sets to correspond with the forty poles of the machine. The flywheel, thirty feet in diameter and weighing 150,000 pounds, is mounted on the armature shaft, as shown in the illustration.

On the alternating-current side of the machine the collector rings are ninety inches in diameter, forty-eight carbon brushes resting upon each. When the full load of the machine is taken from the alternating side, the current volume is naturally enormous on account of the low voltage employed. The machine operates with great smoothness and regulates closely on both alternating and direct-current sides between wide variations of load. It is, of course, self-exciting.

The engine is of the two-cylinder, cross-compound, vertical type, the high-pressure cylinder being thirty-eight and the low-pressure cylinder thirty-four inches in diameter, and the common stroke of the two sixty inches. It operates normally at a speed of seventy-five revolutions per minute and is arranged to work either condensing or non-condensing, as may be required.

A very complete description of the entire plant and systems of the Chicago Edison Company was published in the ELECTRICAL REVIEW of January 11, 1902.



THE 2,500-KILOWATT DOUBLE-CURRENT UNIT OF THE CHICAGO EDISON COMPANY.

The Largest Generating Units in the World.

A Description of the Steam-Driven Alternators of the Manhattan Elevated Railway in New York City.

MORE THAN thirty years ago the problem of transportation in the narrow and confined districts of New York city began to present features that could not be solved with the ordinary means at hand. The solution that was adopted was one that is peculiarly illustrative of the mechanical and engineering genius of the country—an adaptation in the boldest, and perhaps the crudest, manner of existing appliances to do the work. The only methods of surface traction known were the horse car and the steam locomotive. Obviously it was impossible to operate the latter in the crowded streets of a city, while the former was totally inadequate to meet the necessities of the case. Steam locomotives and the speeds of steam trains were evidently necessary; so a steam railway was built in the air, so to speak, elevated upon a continuous bridge many miles in length, accessible only by stations which were placed at intervals along the line.

The elevated railroads achieved an immediate and remarkable success. Probably no other method of transit has ever so enormously facilitated the growth of a city. Certainly no other city has ever grown as did New York, its multitudinous population swarming to the northward as the capacity of this overhead railroad was increased and bettered. But after years of operation, when the number of lines paralleling one another had grown to include practically all of the streets that were open to them, it was found that travel upon them had become so great that the movement of people into and out of the downtown business section of the city had reached a point of such unforeseen magnitude that something better must be provided. Naturally the solution was in the electrification of the elevated railways and the adoption of electricity as the motive power in place of the steam locomotives hitherto used.

Of all the cities using elevated railways, New York is the last to adopt modern methods of traction upon them. Liverpool, Chicago, Boston and other places had already demonstrated the value and the entire feasibility of electrical operation for systems of this kind. It was decided to build in New York an electric railway plant of the most advanced character and, certainly in its magnitude, surpassing anything that had hitherto been attempted.

In the great generating station built on the East River at the foot of Seventy-fifth street are now installed the largest pieces of electrical apparatus ever constructed for any purpose. The method of operating the elevated railroads by electricity is similar to that employed with great success for numerous trolley lines of considerable length throughout the country. Electrical energy is generated as high-tension polyphase current and distributed through underground feeders to substations situated at convenient points with reference to the elevated lines. In these stations the current is transformed in voltage and converted to direct current for feeding the third-rail conductors used for operating the trains. The power-house is in many respects a model of its kind. In it are assembled eight units similar to that illustrated on the opposite page. Each of these machines is rated at a maximum capacity of 12,500 horse-power, and each in itself presents a problem in electrical engineering of no small magnitude.

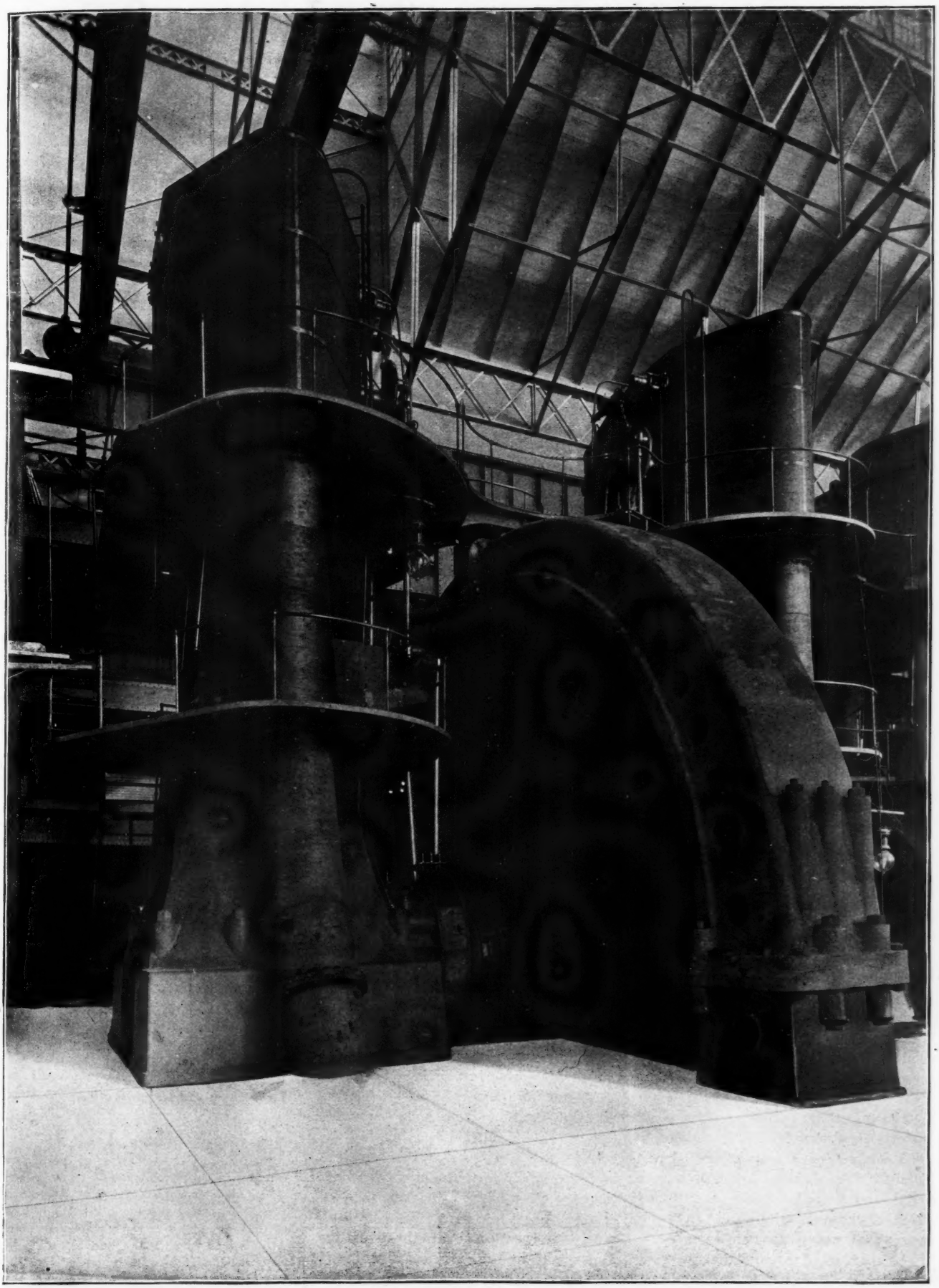
The machines are composed of combination vertical and horizontal Allis-Corliss engines and Westinghouse generators. The engines virtually consist of a pair of compound engines working together on the same shaft, each engine having its high-pressure cylinder mounted vertically and its low-pressure cylinder horizontally. Each of the two high-pressure cylinders is forty-four inches in diameter, and each of the horizontal low-pressure cylinders is eighty-eight inches in diameter, the stroke common to the two being sixty inches. The speed of operation of these machines is seventy-five revolutions per minute. The various cranks are set so that the shaft receives eight impulses per revolution, making the turning effort so uniform that no flywheel save the enormous rotating field of the electrical generator is necessary. Another interesting and valuable advantage of this type of construction is that the engines have no dead centre and may be started from any position in which they happen to stop without difficulty. In the construction of the engines, which were designed by Mr. Edwin Reynolds, there was no attempt made to jacket the cylinders, but the admission valves of the high-pressure cylinders were made integral with the cylinder heads, thereby securing practically the same advantage. Throughout the engines the valve gear is of the Reynolds-Corliss type, the exhaust and admission valves being operated by separate eccentrics. The engines are so built that the two halves can be operated separately, if this should prove to be desirable.

The dynamos attached to these gigantic engines are not of an unusual type, but resemble in many respects smaller machines. They are of the pattern known as revolving field alternators, and are built to deliver three-phase current at 11,000 volts pressure under ordinary circumstances. Should it be desirable this pressure may be increased to 12,000 volts in each phase. The revolving parts of the machine are made of great strength and are designed to resist the stresses due to abnormal speeds or accident. The hub of the revolving part is built of cast steel and the rim is carried by a structure of steel plates instead of by the ordinary spokes. The revolving field is no less than thirty-two feet in diameter, and at its ordinary speed of rotation of seventy-five revolutions per minute its rim runs at the rate of nearly a mile and a half per minute. The weight of the revolving element of each dynamo is 370,000 pounds.

The field poles of these machines are forty in number and are wound with copper strap, wound edgewise. The windings are held upon the poles by copper wedges driven between the pole-tips and are calculated to withstand practically any possible speed of rotation. The exciting current is normally 225 amperes at 200 volts, though this may be increased some fifty per cent in case of necessity.

The armatures of these machines are stationary. Each consists of six heavy steel castings to which the laminated plates are attached. The wave-form of the machines is reasonably smooth and closely approximates a sine curve.

One of these immense generators has been running for some time, operating electric trains on the Second avenue division of the elevated railroad and has given entirely satisfactory results.



ONE OF THE 12,500-HORSE-POWER ALTERNATORS IN THE MANHATTAN ELEVATED RAILWAY COMPANY'S POWER-HOUSE.

The Gigantic Generating Units of the New York Edison Company.

IN the new station of the New York Edison Company, situated at the foot of Thirty-ninth street on the East River, in the borough of Manhattan, New York city, are now being installed eight steam-driven generating units which are among the largest that have yet been constructed. In all there will be finally sixteen of these massive units, each of which is rated at 5,500 horse-power at most economical cutoff.

On the opposite page is shown an excellent illustration of one of these enormous machines. The engines are of the inverted three-cylinder cross-compound type and the generators are of the revolving-field three-phase variety. The engines were built by the Westinghouse Machine Company. Although having three cylinders, they are of the compound type, the low-pressure cylinder being divided. The high-pressure cylinder is forty-three and one-half inches in diameter and each of the low-pressure cylinders is seventy-five and one-half inches in diameter, the stroke common to all being sixty inches. The cranks are set at 126, 133 and 101 degrees on the nickel-steel shaft, which is twenty-six inches in diameter in the bearings. The flywheel is comparatively small by virtue of the peculiar setting of the cranks, and gives very uniform rotation. This flywheel is of 90,000 pounds weight and is twenty-three feet in diameter by sixteen and one-half inches face.

Only the low-pressure cylinders are jacketed, as superheated steam of 175 pounds pressure at the engine will probably be used. At this pressure, with twenty-seven inches of vacuum, the engine, at its normal speed of seventy-five revolutions per minute, will indicate about 5,500 horse-power as the most economical load. On demand, however, it has an ability to develop up to about 8,500 horse-power, thus showing the economical capacity of the station to be between 75,000 and 85,000 horse-power and its maximum output capacity about 135,000 horse-power. The guarantees on these engines contemplate a development of an indicated horse-power-hour with twelve and a half pounds of saturated steam at the economical load, and with superheated steam considerably less.

The shaft rests on four bearings, three of these being sixty inches long, while the outboard bearing is forty-eight inches long. The shaft is of fluid-compressed nickel-steel, forged hollow, ten inches internal diameter at wheel pit and nine inches at the bearings, and is twenty-nine and one-half inches external diameter, and weighs sixty-eight tons.

The valve gear is of the poppet type on the high-pressure cylinders and of the double-ported Corliss type on the low-pressure cylinders. All of the valve gearing is driven from an auxiliary shaft which receives its motion from the main shaft through a helical gear. The governor is provided with an arrangement whereby the adjustment of its weight may be manipulated from the switchboard to bring the engine accurately to speed for synchronism.

The generator was constructed by the General Electric Company and is rated at 3,500 kilowatts, although it can safely carry a load of 4,500 kilowatts for three hours without undue heating.

The machines are of the three-phase twenty-five-cycle type, generating directly at 6,600 volts. The machines have forty poles, the revolving field being keyed to the shaft and also bolted to the hub of the flywheel. Exciting current is furnished at 220 volts, the field winding consisting of copper strip wound on edge. By adopting this exciting voltage it is possible to take the field current either from exciters or from the main switchboard of the direct-current supply or from the storage battery situated in the station. The collector rings are made of cast iron and each carries four carbon brushes.

The stationary armature is of the deep-slotted type, the winding slots being four and one-eighth inches deep by one and one-half inches wide. In all the armature has 240 slots, giving two slots per phase per pole. The frame of the machine carries iron extensions which protect the ends of the coils from accidental injury.

A breakdown test of 15,000 volts alternating for half an hour and a puncture test of 25,000 volts alternating for one minute was specified for the armature to assure satisfactory insulation. The efficiency of the machine at one-quarter load is ninety-one per cent; at one-half load, ninety-five per cent; at three-quarters load, ninety-six per cent; and at full load and up to an overload of twenty-five per cent, the efficiency is ninety-seven per cent. The regulation is constant within eight per cent without change of excitation between the limits of full load and no load—non-inductive.

The total weight of the generator is 275,000 pounds, of which the revolving field weighs 130,000 pounds.

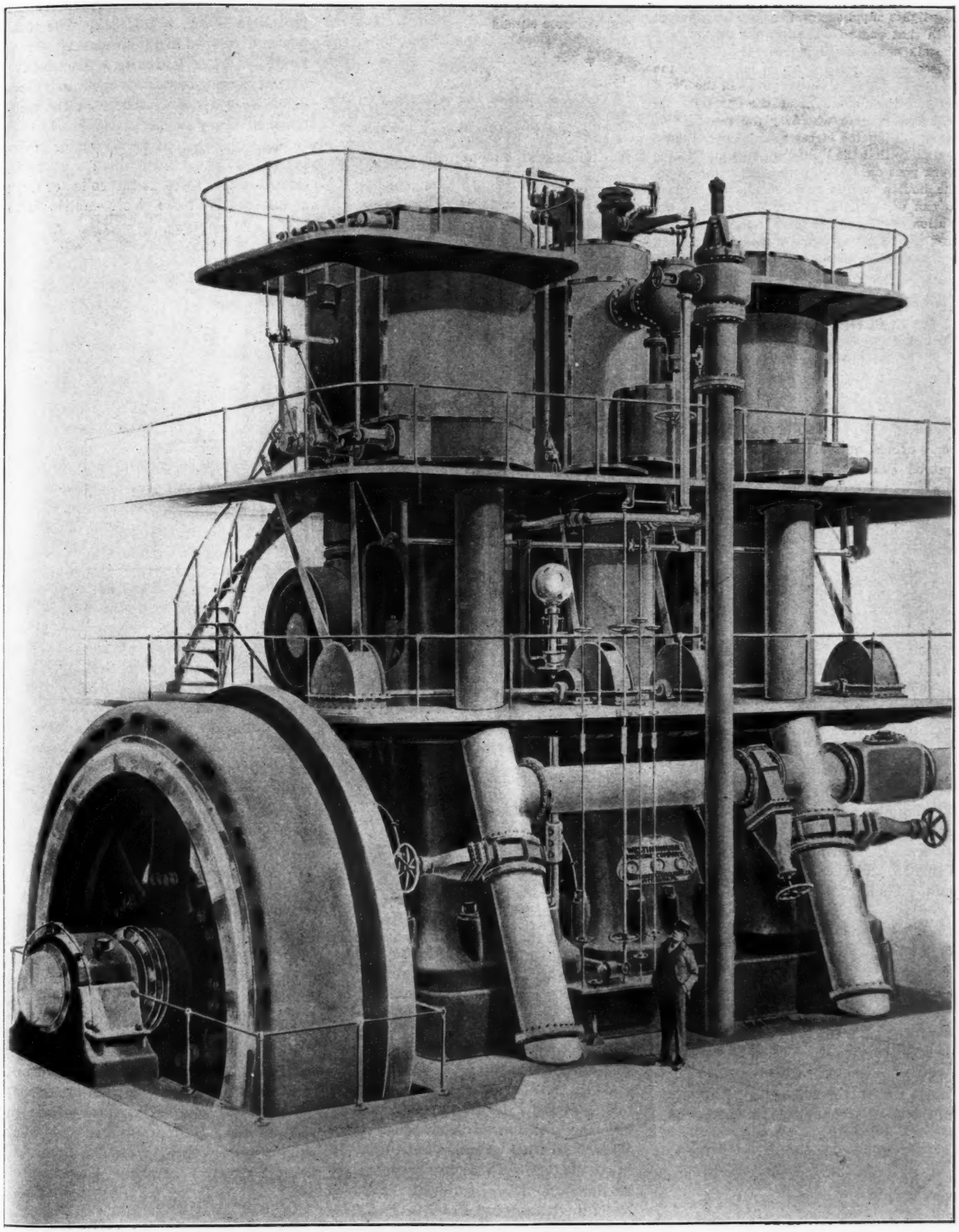
As a notable example of the excellent workmanship of both parts of these units may be mentioned the fact that during the emergency season of the last Christmas week, 5,200 kilowatts was carried on one of these units with complete success.

The new Water-side station of the New York Edison Company, in which these units are installed, is in many respects one of the most notable as well as one of the largest central stations in the world. Just twenty years ago the same company built and put in operation the first central station in New York, distributing current for incandescent lighting and power. The contrast between the old Pearl street station and the new plant, containing the magnificent machines described above, is an apt illustration of the progress of the art during the last two decades. In the Duane street station, built one decade ago, there was introduced for the first time the direct-coupled type of generating unit. These generators were of the then enormous size of 200 kilowatts each.

THE EDISON PLANT OF TWENTY YEARS AGO.

[*From the issue of this journal dated September 15, 1882.*]

The Edison Electric Light Company, which for the last year and a half has been preparing to light up its first district, bounded by Spruce and Wall streets, Nassau street and the East River, turned the current into Drexel & Morgan's offices at Wall and Broad streets yesterday, and the light may now be seen there. In summer the advantages of a light which does away with heat and gas odors, and does not vitiate the air as gas does, are not so easily realized as when more light is needed, and the doors and windows are carefully shut. The light, as seen in half a dozen lamps in Drexel & Morgan's office this morning, was perfectly pure, pleasant to the eye, and so much like gas in color that when covered by a ground-glass globe no one can tell whether it is gas or electricity. It is perfectly steady, and has none of the flickering sometimes due in incandescent lamps to the weakness of the engine which drives the dynamo. The powerful engines at the Edison station in Pearl street run without the slightest jar, for the engine shaft is connected directly with the dynamo, thus doing away with the belt to which in former experiments could be traced most of the unsteadiness in the light. Whenever the



ONE OF THE 3,500-KILOWATT GENERATORS OF THE NEW YORK EDISON COMPANY.

ends of the belt in an ordinary engine pass over the flywheel the effect can be seen in any lights supplied from dynamos connected with that engine. That is one reason why the six enormous dynamos for 1,250 lights apiece have each an engine as part of the dynamo. There is now running in the Pearl street station one dynamo the current from which is sent to wherever the men are at work joining the street mains to the house mains, so that the lights can be tested as the work goes on. At any time after this week the houses having their lamps and meters in can use the light. Mr. Edison is at the station every day, highly delighted with the results of his two years' work, and studying out any obstacles which may present themselves.

THE THEORY OF ALTERNATING DYNAMO ELECTRIC MECHANISMS—LVI.

BY W. ELWELL GOLDSBOROUGH.

Example 24.

Given: An 80-kilowatt alternator, developing a no load voltage of 1,000 volts at 60 cycles, and having a maximum output of 125 amperes. The resistance of the armature of this machine is 1 ohm; the inductance of its armature is 0.01062 henry, which, at 60 cycles, gives a reactance of 4 ohms.

Determine the characteristics of the machine at full load and for overloads, when working on a non-inductive circuit.

To determine the characteristics of this machine, we must first construct its vector diagram. Accordingly, in Fig.134, we will lay off the vector $OA_0 = 1{,}000$ volts. On this vector as a base line, we lay off the vector diagram representing the relative values of the other forces involved by assuming different line and receiver resistances. To aid us in accomplishing the desired results, we can tabulate our data, and thereby work to better advantage. Accordingly, we will refer to Table 18, and there record the calculated data, including the assumed values of the external line and receiver resistance. Taking the first resistance value, $r_1^b = 38.8$ ohms, and substituting it in equations (54) and (55), together with the constant values of $E_0 = 1{,}000$ volts, and $x_a = 4$ ohms, we get $I^b = 25$ amperes. Accordingly, then, the resistance drop in the armature equals $I^b r_a = 25$ volts, the armature reactance electro-motive force equals $I^b x_a = 100$ volts, and the armature impedance electro-motive force equals

$$E_a = \sqrt{(25)^2 + (100)^2} = 103 \text{ volts.}$$

The total electro-motive force in phase with the current equals

$$I^b (r_a + r_1^b) = 995 \text{ volts.}$$

The collector electro-motive force apparent at the brushes equals

$$I^b r_1^b = 970 \text{ volts.}$$

The angle of lag of the current in the armature behind the total internal electro-motive force equals

$$\phi_0^b = \tan^{-1} \frac{4}{1 + 38.8} = 5^\circ\ 45'.$$

The total output of the alternator equals

$$(I^b)^2 (r_a + r_1^b) = 24.86 \text{ kilowatts.}$$

The net useful output of the generator equals

$$(I^b)^2 r_1^b = 24.24 \text{ kilowatts,}$$

The lag of the current behind the total internal electro-motive force OA_0 equals the angle $B^e OA_0 = 23^\circ\ 35'$. The total power developed in the armature is equal to $OP_0^e = 91.65$ kilowatts. The effective output of the generator is equal to $OP^e = 81.65$ kilowatts, and, therefore, the electrical efficiency equals 89 per cent.

The regulation of an alternator is expressed as the per cent which the drop in electro-motive force at the collector rings at full load is of the electro-motive force measured at the collector rings at no load. In the case of the machine at present under discussion, we accordingly find the regulation to be

$$100\ [(1{,}000—816) \div 1{,}000] = 18.4 \text{ per cent.}$$

If we neglect the ohmic resistance of the armature, we find that the regulation, based on the total electro-motive force in phase with the current, is somewhat higher and equal to

$$100\ [(1{,}000—916) \div 1{,}000] = 8.4 \text{ per cent.}$$

We see, then, that the ohmic resistance of the armature of an alternator has an important bearing upon the regulation of the machine, just as in the case of direct-

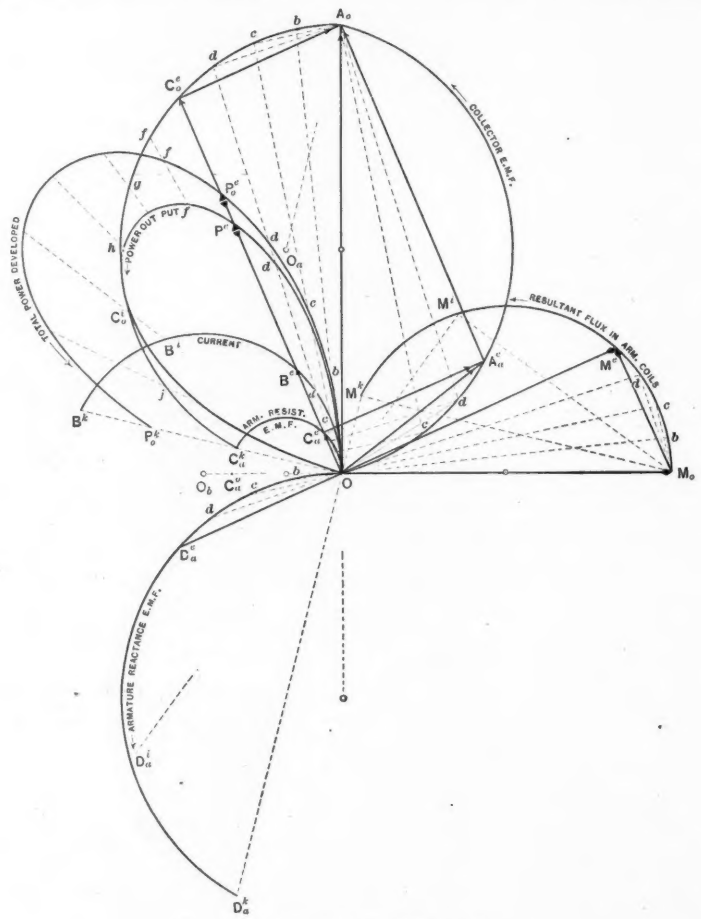


FIG. 134.—ALTERNATING MECHANISMS.

and, finally, the electrical efficiency of the generator is

$$100 \frac{24.24}{24.86} = 97.4 \text{ per cent.}$$

In Fig. 134, these values are shown in their relative phase positions by the dotted vectors indicated by (*b*).

When the alternator is working under full load, the external line and receiver resistance will have a value equal to 8.2 ohms. In this event, substitution in equations (54) and (55) give us the values tabulated as the (*e*) series of Table 18. Accordingly, we find that, in Fig. 134, the vector $OB^e = 400$ amperes; the impedance drop in the armature equals $OA_a^e = 412$ volts; the collector electro-motive force equals $A_a^e A_0 = 816.5$ volts.

current machinery, and that, proportionally, the ohmic resistance has a greater effect than has the inductive resistance. In the present instance, the inductive resistance alone causes a drop of 8.4 per cent, while the combined effect of the inductive and ohmic resistance is sufficient to cause a drop of 18.4 per cent.

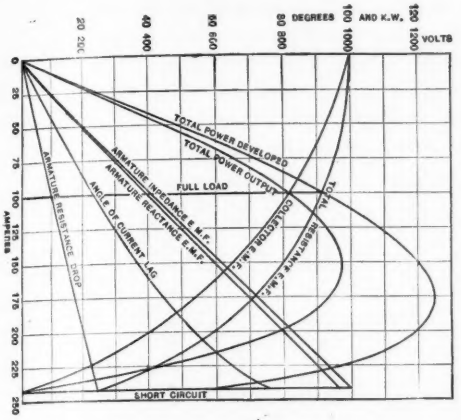


FIG. 135.—ALTERNATING MECHANISMS.

In commercial practice, alternators are built to regulate at full load within from 5 to 25 per cent of the no load voltage; 10 and 15 per cent represent common values.

The data tabulated in Table 18 is complete for all ranges of line and receiver resistance from no load to short-circuit. The (k) series of values shows the conditions prevalent when the alternator is short-circuited. At this time, it is seen that the impedance electro-motive force has a value of 1,000 volts, which is equal and opposite to the total internal electro-motive force. The lag of the current behind the total internal electro-motive force is equal to the angle $B^kOA_0 = 75° 56'$. The power developed is equal to 58.9 kilowatts, which is all absorbed in the armature itself, and represents the work done in forcing the short-circuit current, $OB^k = 242.5$ amperes, through the armature resistance of 1 ohm.

The alternator develops its maximum power when the machine is considerably overloaded. At this time, the line resistance equals 3.1 ohms, and the current lags 45° behind OA_0. The maximum output of the machine is developed when the external resistance equals 4.3 ohms, and amounts to 97.5 kilowatts. The maximum external load, therefore, occurs when the current has a lag of 36° 52′ behind the total internal electro-motive force. The maximum output of the generator occurs earlier than does the maximum power developed by the generator.

In Table 18, we have all of the data which is needed to construct the characteristics of the alternator. These appear in Fig. 135. The abscissæ of this figure are the current values given in Table 18. The ordinates of the characteristic curves are the corresponding electro-motive force, power, and angle

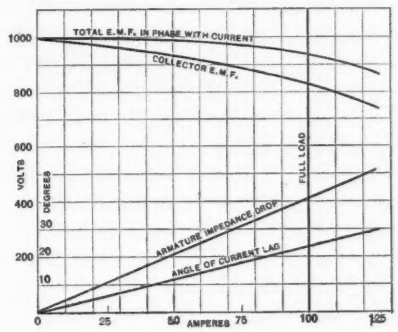
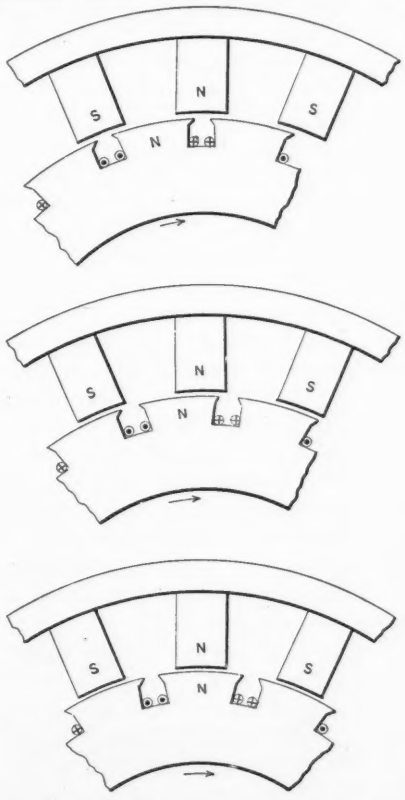


FIG. 136.—ALTERNATING MECHANISMS.

values of Table 18. With this explanation, the variations which take place in the several factors, as the load comes on, can be readily followed. As already explained, the total power developed comes later than does the total power output. The total power output in the present case is reached somewhat later



FIGS. 137, 138 AND 139.—ALTERNATING MECHANISMS.

than the full load rating of the generator. We thus see that, where the field excitation of a machine is not changed, the total output of the machine is limited. Between no load and full load, the angle of lag of the current behind the total internal electro-motive force increases practically proportionally to the current, and only deviates markedly from this proportional relation when the current is very heavy. It is noticeable that the power curves build up comparatively slowly, but fall off very rapidly after the maximum power points have been reached. The electro-motive-force curves of Fig. 135 have been considerably fore-shortened, in order to bring within its limits the complete characteristics from no load to short-circuit. Commercially, the load on this machine would not be carried above 125 amperes. The 125-ampere point, therefore, limits the working range of the characteristics. Fig. 136, accordingly, represents to a better comparative scale the regulation of this alternator, and enables the characteristics to be mentally compared with like characteristics of direct-current machines.

By way of throwing further light upon the reactions which take place between the magnetizing forces due to the field currents and those due to the armature currents, attention is now directed to Figs. 137, 138 and 139. When an alternator is working under a light, non-inductive load, the armature current is very nearly in phase with the total internal electro-motive force developed in the armature windings; therefore, the current in the armature will reach a maximum when the coils have the positions shown in Fig. 137. The magnetic flux set up by the armature in this case will have no tendency to traverse the magnetic circuit followed by the field flux, and, consequently, it will neither tend to increase nor diminish the value of the total flux enclosed by a field coil. As the load upon the alternator is increased, the armature current lags behind the total internal electro-motive force. The latter always reaches its maximum value when the coils are in the position shown in Fig. 137. If, however, the lag of the current is as much as 45°, the current will not attain its maximum value until the teeth have advanced to the position shown in Fig. 138.

It is reported from Paris that M. Ducretet is engaged in carrying out experiments on wireless telephony from which he has already obtained results which he considers are very promising. M. Ducretet's name has been associated with that of M. Popoff in connection with some very successful work in the development of wireless telegraphy. His present experiments do not seem to have gone beyond the laboratory stage, the distance over which speaking has been conducted being only thirty yards. The telephone currents pass through the ground, and it is said that M. Ducretet is about to investigate the conduction through different soils.

THE CONSTRUCTION OF SMALL TELEPHONE EXCHANGES—XXVI.

BY A. E. DOBBS.

In previous articles it has been taken for granted that the reader was, to a greater or less extent, familiar with the appliances described, but having now pretty thoroughly covered the outside construction we shall proceed to a detailed description of the appliances connected with instrument switchboard fittings, which, after all, are fully as important as the outside construction.

Upon the efficiency of the board depends the character of the service rendered, for in these days of keen competition and close prices an exchange must have a large subscription list in order to earn money. In order to have a large subscription list there must be quick, reliable and good service, and by good service is meant a service that will not keep a subscriber waiting for more than four or five seconds for an answer from the operator after he calls in; that will enable him to always make himself understood by the party to whom he is talking and on which parties with whom he is not conversing shall not hear what he is saying, unless he is satisfied with party-line service, in which case he takes his chances, and that his line shall —in at least nine hundred and ninety-nine times out of a thousand—be nearly as ready for use as that of water or gas service. This may seem like an impossible ideal to work to, yet we should all strive for perfection and attain as nearly to it as possible.

Quick service may be attained by means of (*a*) strict discipline of the operating force; (*b*) the most perfect switchboard appliances, those which will register signals quickly and reliably; (*c*) by instruments at the subscribers' station that are so well made that they will always do the work required of them; (*d*) by good line construction and using as much cable as possible.

Reliable Service—It is to be regretted that manufacturers have not, as yet, succeeded in producing perfect instruments, but they are working in that direction as fast as they can, and at the present rate of progress we may look for a big improvement within the next three or four years, for manufacturers are doing their best to improve their part of the work, and offering every encouragement to inventors for ideas of practical value, but we must remember that for at least ten years anything like real progress in telephone appliances was at a standstill, until the invention was thrown open to the world; and even then, and to a certain extent at the present time, there were restrictions in the form of existing patents that made considerable trouble for the independent manufacturer. Then, for three or four years, the independent exchanges would or could not pay the price necessary to procure first-class instruments—nor were manufacturers in a position to turn them out—and even at the present time prices are too low to secure instruments of the best quality. To start a factory at the present time, even on a small scale, for the manufacture of telephones and switchboards requires an investment of about $50,000, with the chances that in a year or two models and machinery will have to be changed, requiring a still further addition to the capital stock, and only by a constantly increasing demand for telephone appliances of all kinds can they make a profit at present prices.

Under these circumstances the temptation to economize on first cost is very great.

In the magneto call instrument the ringers, switch and generator have become to a certain extent standardized and are therefore fairly reliable, but still we have quite a number of movable contacts, and these demand careful inspection.

SPECIFICATIONS FOR GENERATOR, SWITCH AND RINGERS.

1. The generator intended for ordinary series instruments must be capable of ringing clearly an eighty-ohm bell through a non-inductive resistance of 10,000 ohms.

2. The field magnets of the generator must be nickeled or enameled to prevent rust and must not show any more than five per cent loss of magnetism within one year from the date of purchase, which means that a generator which will ring an eighty-ohm bell through 10,000 ohms' resistance when purchased must ring the same bell through a resistance of 9,500 ohms after being in use one year.

3. The generator shunt shall be positive in its action, not liable to get out of order, open readily and ring the bell (if the bell is in circuit) at one-half revolution of the handle.

4. The gears shall be machine cut, not less than one-fourth of an inch in width, and have a smooth and as nearly as possible frictionless action and all wearing parts thoroughly and substantially made, as well as mechanically correct in every particular.

5. The armature of the generator shall consist of thin punchings of soft iron, cut to the requisite shape and fixed firmly upon the shaft, and be well balanced electrically and mechanically; the windings of this armature to be of pure, soft copper wire, covered with silk, which shall also be carefully and still further insulated from the body of the armature and shaft by some tough, durable and non-hygroscopic material as silk cloth, shellaced paper, fibre or micanite, and the winding firmly secured in such a manner that it can not become displaced.

6. The switch hook shall preferably, though not necessarily, be of the long-lever pattern, which shall make a strong rubbing contact with its springs in both the "up" and "down" positions; it shall be of such form as to ensure the minimum amount of wear and not easily get out of order; there must be no movable wire attached thereto and no contact made through the hinge on which the hook moves.

7. Contact springs to be of best spring-tempered German silver, not less than 0.04 of an inch in thickness (No. 18 Brown & Sharpe gauge), nor less than three-eighths of an inch in width, and preference will be given to those making platinum contacts in both the "up" and "down" positions; provided, that where steel springs are used and the contact made through platinum points they may be a little thinner than 0.04 of an inch.

8. All wire used in the wiring of the generator box to be of bare, thoroughly tinned copper wire, not smaller than No. 20 Brown & Sharpe gauge, except when it may be necessary to cover the wires to prevent contact with the machine or other wires, in which case a sleeve consisting of a double braid of cotton, filled with shellac, may be slipped over them; soft rubber tubing will not be tolerated. Preferably, the wires should be placed in grooves in the back of the box, said grooves to be deep enough and wide enough to allow the wires to lie therein, surrounded by a considerable amount of air space, and all connections to the binding-posts or spring contacts to be soldered.

The wood of the generator box, both inside and out, must be filled with either oil, varnish or shellac to prevent the absorption of moisture, and wires leading from the back of the box to the switch clips must not be so tightly drawn as to break, in case the wood should swell from moisture. [NOTE—This is a trouble occasionally found in some otherwise good instruments.]

10. The circuit leading from the generator to the ringer coils, where they are placed on the door of the box, as is generally the case, should avoid the hinges, if possible, but where flexible wire is used this is liable to become broken. Therefore, where the circuit leads through the door

hinges these should be provided with springs, which will at all times ensure a constant pressure against the two halves of the hinge, and contacts between the hinges and wires must be thoroughly soldered.

11. All wires connecting to spring clips and hinges must be so connected as to be held in place mechanically and afterward soldered to ensure reliable electrical contact. In no case must solder alone be relied upon to hold wires in place or to hold a splice together.

12. Staples must not be used to hold wires in place, for it is better that wires should lie loosely in the grooves than stapled down. Where, however, it is necessary to bind a wire to prevent possible contact by its slipping out of its groove, a small, flat-headed tack may be employed. Where necessary to secure the lines leading from the back of the box to the switch contacts, a small brass wire nail may be used and the wire held by taking a single turn around it.

13. If fuses or carbon lightning arresters are used on the box, they must be mounted in such a manner as to be readily accessible and not placed back in the box out of easy reach.

14. Bells should be of brass or bell-metal, heavily plated, well finished on the outside and so mounted as to be adjustable. In no case must iron or steel gongs be used.

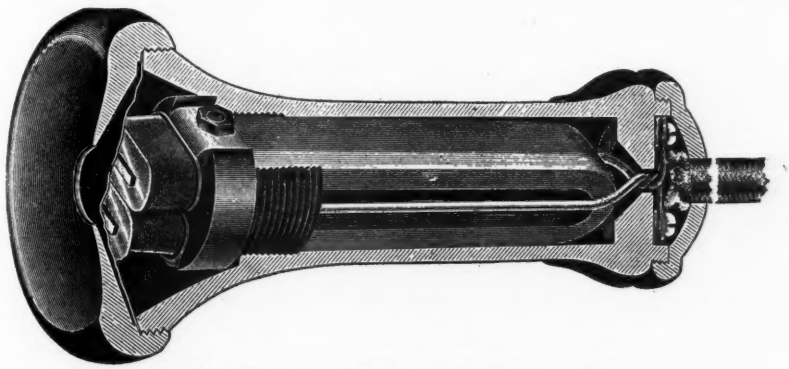


FIG. 108.—RECEIVER MAGNETS ADJUSTABLE AT TOP.

RECEIVERS.

In the selection of a receiver there would at first sight seem to be little choice, as all are made upon practically the same pattern so far as magnets and spools are concerned. Preferably, the permanent magnet should be made in one piece, ending in two bobbins which constitute the electromagnets, making what is known as the bipolar or two-pole form, to actuate the diaphragm. All have bobbins wound to a resistance of from sixty to eighty ohms, and all are, or should be, strongly magnetized. There are receivers manufactured which have magnets strong enough to lift a four or five-pound block of iron, but, while this is a good thing in its way and generally quite desirable, such receivers are not necessarily the best.

With a comparatively weak magnet, the receiver diaphragm is thin and closely adjusted to the bobbins. With a strong magnet this diaphragm is made heavier and, therefore, a little more sluggish in its action and given a wider adjustment in order to resist the heavy pull and, so far as the writer's observation goes, it seems possible to go to the extreme in the matter of charging magnets, for while some of these powerful receivers are good "talkers," there are others with half their magnetic strength that do equally as well. If, however, a firm advertises a receiver magnet that lifts four-pound weights, and the thickness and adjustment of the diaphragm are made to correspond, then all receivers received from that firm should be able to lift four-pound weights in order to keep them up to the standard adopted and obtain their best work.

It is desirable that a receiver of this kind should be adjustable, for the reason that when new, and the magnetism strong, the adjustment may be rather wide, but after two or three years, as the magnetism falls off, a closer adjustment is necessary to enable the receiver to still retain its loud-talking qualities.

FIG. 107.—RECEIVER MAGNETS ADJUSTABLE AT BASE.

Of course there are manufacturers and engineers who will raise the objection that an adjustable receiver in the hands of the average inspector will be a constant source of trouble, but this does not seem to be well founded. Besides, no matter how carefully receivers may be adjusted before leaving the factory, it occasionally happens that one will need readjusting, and it is very convenient to be able to set it right without taking it back to the shop.

There is another, a mechanical fault, that in the past has caused a great deal of annoyance to nearly all telephone companies that use hard rubber shells, caused by the difference in expansion and contraction between steel and rubber due to changes in temperature, the movement of the steel being considerably greater than that of hard rubber. To illustrate, let us take up Fig. 107 which represents the old style of receiver which fastens by means of a screw to the lower end of the case. It will not require a great deal of study to see that all movements of the magnet caused by expansion and contraction must be toward and away from the diaphragm, and that in winter the adjustment would be too wide and on a hot summer's day too close, as there is the expansion of about six inches of steel. In modern instruments, however, this fault is overcome by securing the receiver to the case at the top instead of the bottom, which does not leave more than about an inch of the bobbins to expand and contract toward and from the diaphragm, all the rest of the movement being back in the shell where it can do no harm (Fig. 108).

This difference between rubber (or its substitute) and steel has led to the use, in some cases, of metal as a casing for the magnet instead, but this is open to the objection that there is always a possible danger from static or other high-tension currents on the line, and, though this has been disputed—and it is a fact that injury to persons using a telephone is rare—yet there is no use in taking any chances. A form, for example, like that shown in Fig. 108, possesses no exposed metal parts for the hand to come in contact with and would, therefore, be safe against 6,000 or more volts, is neat in appearance and costs no more than the metal-encased receivers.

Manufacturers have long been looking for a satisfactory substitute for hard rubber to use in receiver shells, but, so far as the writer knows, they have not yet succeeded, for most of these substitutes are short-lived or affected by heat and moisture, which causes them to swell, which often affects the leading-in wires, loosens the binding-posts, reduces the insulation and throws them out of adjustment. These substitutes are well enough in a dry and fairly even climate, but if you wish the best, specify hard rubber shells, at least until sure that a satisfactory substitute has been found.

Telephony in Great Britain.

Competition with the National Telephone Company.

(By Our Special Correspondent.)

THE HISTORY of British telephone enterprise has been one long triumph of company monopolization, and, in the light of after events, one is inclined to endorse the opinion of Sir William Preece recently uttered in the course of his address to the Society of Arts. As late engineer-in-chief to the General Post Office, his opinion must necessarily carry weight, and the following is sufficient to indicate how the attitude of the government has impressed itself upon the mind of such an authority: "Twenty-four years have passed since I brought the first pair of telephones to Europe; and it would have been everywhere but for mismanagement. . . . The law decreed that telephony, as a message earning machine by electricity, was included in the Postmaster-General's monopoly. The government never firmly faced the situation. . . . Confusion became worse confounded. The real and only solution has not yet been taken. A cheap, efficient and reliable service is imperial."

Undoubtedly, in the British Isles, there is a rapidly growing tendency to municipal trading, to which, of course, there is strenuous opposition from those interested in an opposite direction. Indeed, the question of municipal *versus* company trading is fast becoming one of more than ordinary significance here, and discussion upon such an involved subject might well be carried on without limitation. This question of telephonic competition, however, is only one of the phases in an extremely far-reaching controversy, the advocates on both sides of which fight on somewhat unusually equally substantial ground. But whatever difficulties were encountered by the pioneer telephone companies in England in the early days of the industry—and these were, admittedly, considerable—the National Telephone Company has, since the period of the total extinction of its competitors by a process of absorption and litigation, taken full advantage of the monopoly thus secured. Hence the telephone public throughout the kingdom hailed with a certain amount of delight the agitation raised by the Glasgow Corporation, which commenced in 1893, for an alteration of such a state of things. Although the object of the Glasgow municipality was, naturally, to obtain a licence to work an exchange for the benefit of its own inhabitants only, the result of its appeal was that in 1899 the Telegraphs (telephonic communication) Bill was passed, which, for the first time, permitted competition with the National company. The opportunity thus afforded has been gradually taken advantage of by numerous local authorities, and the announcement that the government, in the person of the General Post Office, contemplated undertaking a service for London received general approbation. Within a very short time Tunbridge Wells, Glasgow and London had given out contracts for their exchanges and equipments, and, by reason of its smaller area, the former authority opened its exchange in July, 1901, with a subscription tariff something like thirty per cent less than that of the National Telephone Company. Then, in August of the same year, the Glasgow Corporation started up a much larger exchange, capable of accommodating 5,000 subscribers, with a similarly cheap tariff.

These two instances, coupled with the ministerial promises at the time of the passing of the above-mentioned Act of Parliament, produced a feeling of security in London that a proportional reduction would be made in the subscription to the Post Office service in comparison with the £17 per annum for unlimited service charged by the company. But after enduring the worrying inconvenience of the streets being laid open for nearly eighteen months in order that the system might be laid in an efficient manner without risk of breakdown (an inconvenience which the company was never indulged in, inasmuch as it was refused the right to lay underground wires) the London public generally were mortified and startled to learn that in the meantime agreements had been entered into by the Postmaster-General and the National company which confined, to use the company's own words, "the competition . . . to the efficiency of the service and the convenience of the public." In other words, there was to be "competition" as regards quality of service and "cooperation" as regards working arrangements. Under these circumstances the Post Office tariff differed but slightly from that of the company. For unlimited service it is the same, while for a second connection it is slightly higher. At the same time a message rate system has been introduced which, however, can hardly be regarded as an ideal one. The agitation excited by all this is far from dead, even now, and when Parliament again meets—ere this is published—the matter is to be brought up presumably with the object of ascertaining whether it is legal for Parliament to invalidate the agreements entered into by Lord Londonderry, the Postmaster-General, with the National company, a deputation to him organized by the London County Council and another conference having failed in achieving anything of a material nature.

In the provinces a more progressive policy is being pursued by the local authorities, a number of which have received licences, and in no case have the proposed tariffs been anything like those in vogue hitherto. Only in one instance, as yet, has a company applied for a licence, I believe, the Postmaster-General having granted the necessary powers to the Norwich Telephone Company.

Up to the present three competitive systems have been put into operation, and the following brief descriptions of them will serve to indicate their design and magnitude. It is possible, however, that several others will commence operations during the year, while a departure is being made in a few instances in the promotion of bills before Parliament for sanction to a combination of a number of local authorities to work under one licence, for example, Manchester and environs, Hull and others.

THE TUNBRIDGE WELLS MUNICIPAL EXCHANGE.

The corporation has been well supported in its telephone enterprise and takes credit for being the first to open a municipally competitive system with the National company. Starting with a very few subscribers it can now point to more than those of the company, a significant tribute to the following tariff, *viz*, £5 17s. 6d. per annum for unlimited service, or £3 per annum and one halfpenny per call or £2 8s. per annum and one penny per call. Mr. A. R. Bennett, the general manager and engineer to the Glasgow corporation telephone department, acted as consulting engineer for the scheme, and among several unusual features one finds the exchange room on the ground floor. All the conduc-

tors leaving the exchange are carried underground through the town, overhead lines being afterward utilized. The initial cost of the undertaking was some £10,000, and the area served covers 250 square miles, but the number of subscribers having now reached over 600, application has been made for the loan of an additional £15,000.

The switchboard is arranged in panels of fifty subscribers, and is of the vertical type, in opposition to the Glasgow board. As in the case of both Glasgow and London, the cables are lead-covered and paper-insulated, and at present one 312-pair, two 168-pair and one 48-pair cables enter the exchange. Both bronze and copper wire is employed, the former for the subscribers' connections and the latter for the junction wires. Compressed air can be forced through the cables, if necessary, for the maintenance of the insulation. The system of connection of the subscriber employed allows of two subscribers to ring through to each other without signaling the exchange, in addition to which it is impossible for the operator at the exchange to overhear any conversation. The ring-off indicators are actuated by a device which restores the shutter as soon as, on disconnecting, the plugs are put into their sockets. Thus a subscriber is assured of free uninterrupted use of a line until his conversation has finished.

If anything, the efforts of the National Telephone Company in this small town to beat down this municipal competition have been more vigorous than anywhere else, and a method of party lines for ten subscribers has not met with much success.

Fig. 1.—The Glasgow Main Telephone Switchboard.

Indeed, the municipality possesses more than one advantage, for its area is twice as large as that of the company, even now its fees are lower, and in disconnecting all the municipal offices, fire brigades, cemetery, electric light works, etc., from the company's system, has practically issued an open challenge. Continuous service day and night, Sundays included, is given and the financial results, so far, are on the right side.

THE GLASGOW CORPORATION SYSTEM.

As will be gathered from my earlier statement, Glasgow stands out prominently in telephonic development in Great Britain, and here again, as at Tunbridge Wells, a huge success promises to be the reward of its perseverance, for just recently orders have been given for the extension of the switchboards to accommodate another 5,000 subscribers—*i. e.*, 10,000 in all—a by no means insignificant increase in less than a year. The corporation's licence under the Telegraphs (telephonic communication) Bill was granted on March 1, 1900, and the area embraces approximately 143 square miles. At the desire of the corporation the licence was made terminable on December 31, 1913. Application was then granted by the Secretary of State for Scotland to borrow £120,000 and Mr. A. R. Bennett was appointed general manager and engineer. Under this gentleman's advice the Telephone Committee has adopted two tariffs, *viz*, £5 5s. per annum for unlimited service over the whole area or £3 10s. per annum and one penny for each call payable by the caller only. The original scheme was for 5,250 lines with provision for a similar number, but so great was the

demand before the period of commencing operation that the switchroom has been made capable of extension to deal with 20,000 subscribers. In the centre of the city the lines are entirely underground, the main routes further out being overhead as are the spurs into subscribers' premises.

FIG. 2.—GLASGOW TEST BOARD, LIGHTNING PROTECTORS AND HIGH-VOLTAGE GUARDS.

Although the official inauguration of the system did not happen until August last year, the exchange had really been working since March in a small way. At the later date (August) some 16,500 miles of copper wire were laid and consisted of forty-one miles of cable, the central exchange then having accommodation for 3,000 subscribers. To date, however, the orders on hand are some 3,000 and the number of instruments working nearly 6,000. June 2, 1900, witnessed the opening up of intercommunication between the system and the government trunk lines.

The main board, as seen in Fig. 1, is not of the more usual type, but is a flat board fitted with the plugs and jacks above the heads of the operators, a system which has several obvious advantages. As a matter of fact, the board is hardly comparable with any known exchange. The canopy of the switchboard, as is seen, hangs directly over the switch table, and contains the connecting cords. The system of working is the "call wire" method, with which Glaswegians are already familiar, on the one hand, and in which each subscriber, doing his own ringing up, accelerates the work of the operator to a marked degree. The top floors of a large building in Renfield street are utilized for the central exchange, which will eventually accommodate 20,000 subscribers. Some half dozen sub-exchanges have also been arranged. At the main exchange, the cables are carried up outside the wall of the building in a specially constructed rack.

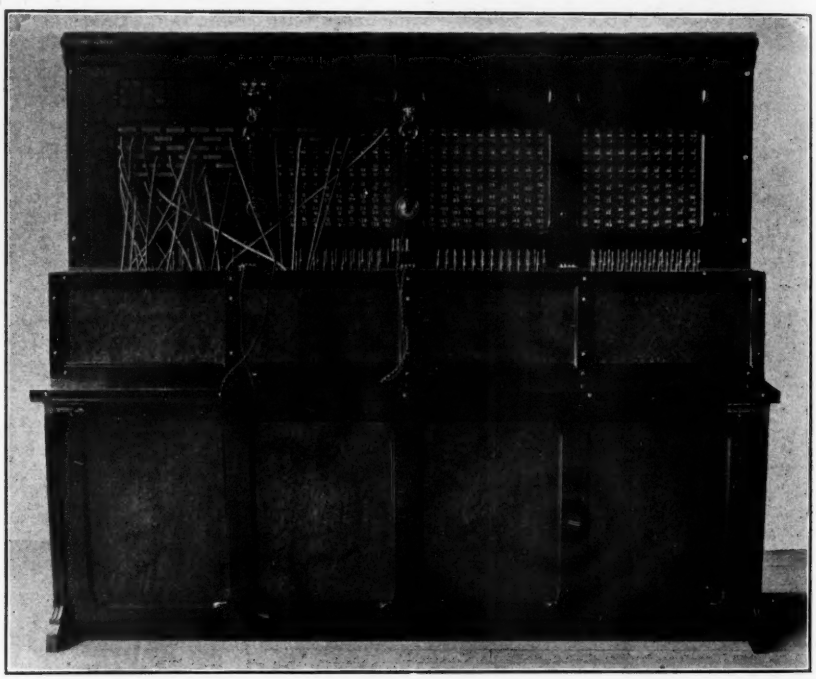


FIG. 3.—GLASGOW CABLE WIRE DISTRIBUTION BOARD.

All the cable work was carried out by the British Insulated Wire Company, and consists of both armored and unarmored cable. The former is lead-covered, and armored air-space distributors varying from 120 to 8 pairs, which terminate in the outlying districts at the ordinary poles which carry the wires overhead. In the central part of the city the unarmored cables are laid in three-inch cast-iron pipes, of which there will be eventually over 100 miles. These cables are also air space, the largest containing over 600 wires, 20 and 22 S. W. G. is used and great care is exercised in testing before any subscriber is connected up. Fig. 2 shows the test board, including lightning arresters and high-voltage guards, while Fig. 3 is the view of the call-wire distribution board, to which all the call wires are led and placed under the control of a superintendent. On some of the outlying circuits, however, a system known as the Bennett-McLean system has been introduced in preference to the "call wire." In this the subscriber, by pressing the call key, actuates a differential relay at the exchange and the operator is put in circuit, only to be cut out again when the call key is released. The method is not suitable in busy areas, however.

Generally speaking, the equipment of the exchange, which the above description will serve to illustrate, gives a freedom of movement to the operators not associated with the vertical type of board, and an arrangement of double flooring on each side of the switchboard enables an access to the wires leading to it equal to that of other methods. A feature of the equipment is the quantity of British made material employed, only a very small percentage being manufactured out of the kingdom.

From a commercial point of view many experts differ as to Mr. Bennett's esti-

mates for initial cost per subscriber and predict that it will be impossible for the corporation to make a profitable undertaking of it. Among these authorities one notices Sir W. H. Preece, and the financial result of the first year's working in Glasgow will be anticipated eagerly by all interested in the problem.

THE POST OFFICE LONDON EXCHANGE.

Although this exchange and the London Post Office system generally have been so prominently before the public for some little time, at the moment of writing these notes no subscribers had been actually connected up. At present four exchanges are in course of construction for providing a telephonic service to an area of over 600 square miles, inhabited by a population of 6,000,000 people. The city exchange, however, is the one most advanced and of the greater interest to business people.

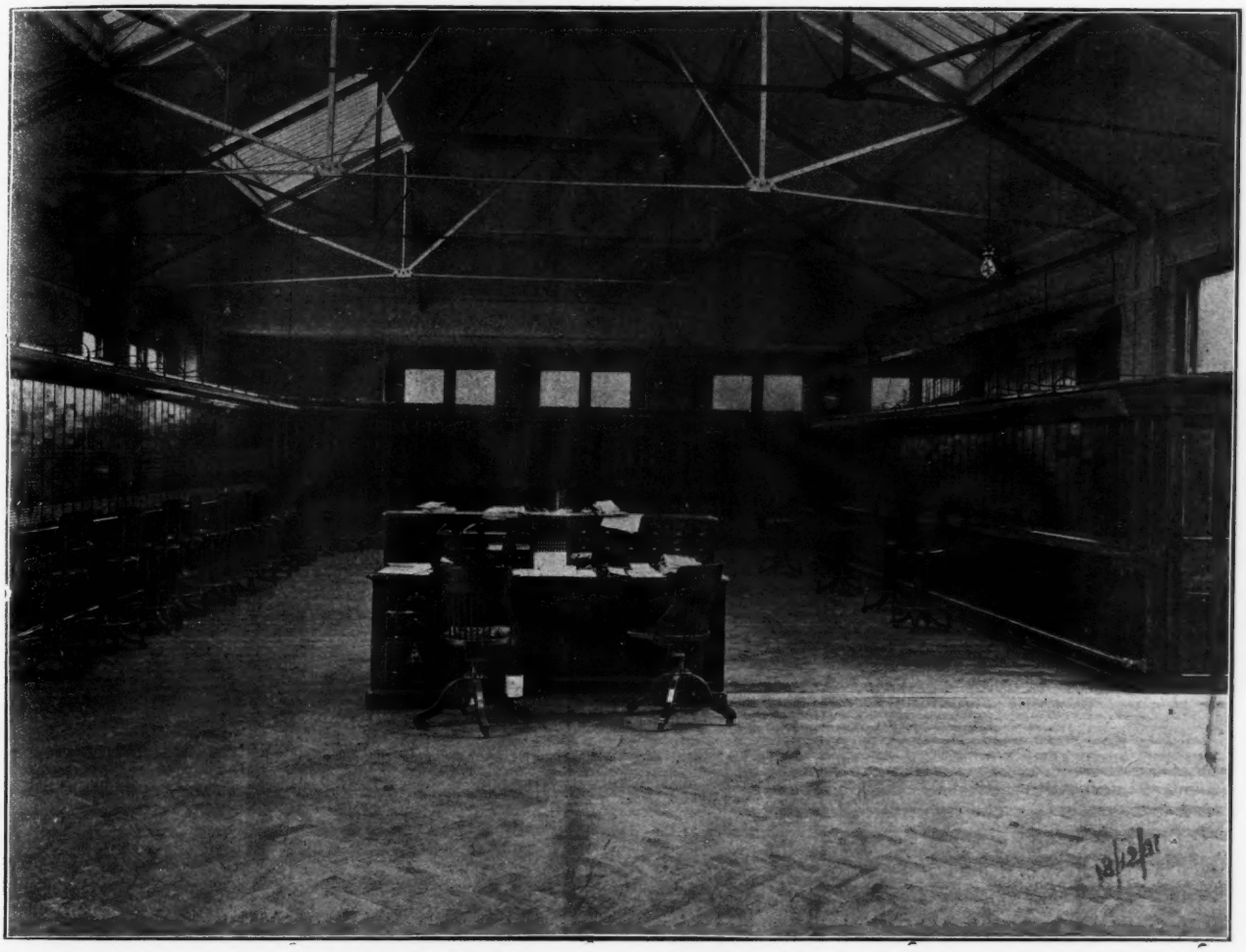


FIG. 4.—POST OFFICE, LONDON, MAIN TELEPHONE EXCHANGE.

The photograph, Fig. 4, gives a view of the first section of the department's central switch which represents the main switch with an immediate capacity of 4,500, together with the incoming junction board on the right-hand side. The utmost capacity of the switchboard is 14,500 subscribers and extensions are already in hand. The Post Office Savings Bank Department has found accommodation in its building for the central exchange and its equipment, for which two basements and a top floor have been allocated, the latter allowing of extension. The system adopted at this depot to which only "unlimited call" and individual message rate subscribers are connected, is one by which the magneto generators and batteries, so common in the National company's subscribers' instruments, are dispensed with, all the necessary current for any subscriber's wants being provided for at and supplied from a power plant situate in one of the aforesaid basements. This plant comprises two motor-generators, each made up of a twenty-five-horse-power, four-pole, shunt-wound motor, flexibly coupled to a generator of the shunt-wound four-pole type which has an output of 500 amperes at thirty volts and 650 revolutions per minute.

In connection with this plant are two eleven-cell C. B. chloride batteries, with a capacity of 2,000 ampere-hours and a discharge rate of 250 amperes. For the ringing current a couple of two-ampere, seventy-five-volt motor-generators are installed, which run at 1,000 revolutions per minute.

The present intention is that each operator at the switchboard shall command 180 subscribers, but facilities are at hand, should this number prove excessive, to transfer some of these to another operator. The relays and repeating coils are provided with dustproof covers upon a rack in the same room, at the back of which are the meters used for registering the number of calls made by subscribers on the toll system. Exception has been taken to the design of these meters on the ground that only the number of calls is recorded, and no statement is given to the subscriber as to when or with whom the calls were made.

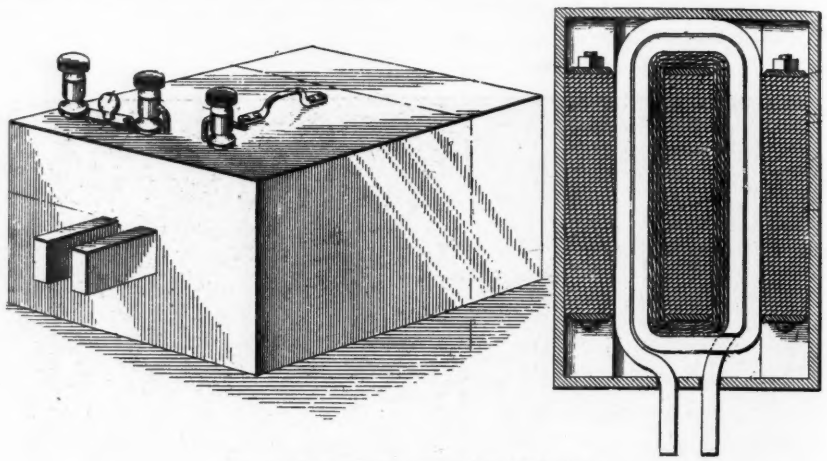
In the basement, into which the cables run from the underground conduits in the streets, there are 214 ducts coming from three entrances, each duct being capable of holding a 217-pair cable. These cables, which are lead-covered, paper and air-insulated, are held on a rather ingenious rack arrangement, and the insulation of these cables is maintained by motor-driven air pumps.

The party-line subscriber, who will only be connected to the exchanges dealing with that portion of the area outside the city, ranges up to ten-party lines, but this part of the equipment is not yet complete and many details have to be settled.

Mr. Javey, the electrician to the General Post Office, kindly supplied the photograph of the exchange, and he is to be congratulated upon the excellence of the equipment as a whole.

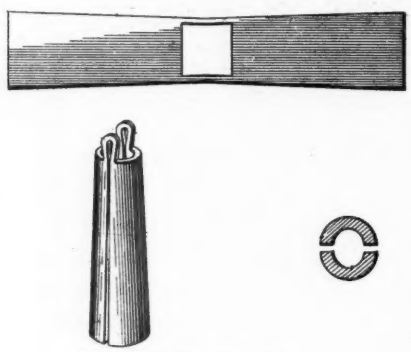
Electrical Patents

A novel idea in portable electric welding machines has just been devised by Mr. Henry E. Meyers, of Butte, Mont., the object being to provide a device which can be conveniently carried by hand from place to place so that it may be employed for heating rivets and similar metallic articles at the place where such articles are to be used. In carrying out the invention he provides a rectangular casing having a suitable handle, and within this casing secures a block that is composed of laminated metal plates bolted together. This block is provided with two parallel slots or openings forming an intermediate core about which is wound a primary coil preferably of armature wire, this coil being held in place by blocks secured in the slots over the same. The secondary coil surrounds the primary coil and fits snugly in the slots. It consists of bar metal approximately twice as wide as thick, the ends or terminals of the same projecting through the wall of the casing and spaced apart. The form and relation of these terminals to each other are unimportant, as they may be employed for heating one or more bolts to the requisite temperature for riveting in bridge or viaduct work and analogous construction, may be employed by a blacksmith to heat horseshoes, may be employed to heat the ends of picks or drills preliminary to sharpening them, for heating the ends of metal of the same or varying sizes to be welded together and, in fact, may be used in such a variety of connections that it is impracticable and unnecessary to attempt to enumerate them all, it being understood, of course, that the articles to be welded must be of smaller area than the terminals of the secondary coil. Otherwise the insulation of the primary coil would be burned out and also cause a burn-out of the secondary coil. When constructed, about seven by seven by four and one-half inches in size, the machine weighs about forty pounds and may be conveniently carried by hand up a ladder to the top of a building, bridge or other structure or down into a mine where any kind of work within its capacity may be done. The primary coil is connected with suitable binding-posts secured to the exterior of the casing so that any suitable source of alternating electrical current may be connected thereto.



Portable Electric Welding Machine.

An ingenious bonding pin has just been patented by Mr. Clarence A. Holdridge, of Chicago, Ill., who has assigned his entire interest to David S. Wegg, of the same city. The invention relates solely to the pin for securing a wire within holes formed in the adjoining rails of a track. It is made hollow and consists of a plurality of longitudinal grooved sections, these grooved sections being tapered and united at their smaller ends by straps. While this bonding pin may be constructed in any suitable manner the inventor intends to make it of sheet metal. A blank is rolled so as to taper both on its flat surfaces and edges from its ends toward the centre, and an opening is punched through the centre, thereby forming straps on either side of such opening. The two portions on opposite sides of this



Rail Bonding Pin.

opening are then stamped into semicircular shape and afterward bent so that their edges are brought together forming the hollow pin. It is applied in the following manner: The end of the wire is passed through the opening in the rail, and the smaller end of the pin is placed about it and in the opening, this end being slightly smaller than the diameter of the opening the pin may be readily driven through the hole, thereby crowding into close engagement with the rail and with the terminal of the wire.

Influence of Hydrogen on Iron.

The influence of hydrogen upon iron forms the subject of a series of experiments made in the Charlottenburg technical laboratory by R. Heyn. The gas is allowed to act upon iron at red heat, and it is found that the latter is considerably affected. In the first experiments he found that iron heated to redness and plunged in an atmosphere of hydrogen, then tempered in water, became brittle, and that this brittleness is especially remarked in the trials of cold bending. On the other hand, if the iron is again heated at a rather low temperature in a water or oil bath it becomes much less brittle or even regains its original state. The same phenomenon is observed when the pieces are allowed to remain in the open air at the ordinary temperature. The time required for the iron to come back to the normal state varies with its constitution.

Magnetic Observatory Influence.

Recently Mr. Mascart presented to the Académie des Sciences de Paris a note by Mr. T. Moureaux on the influence of street currents on the earth's magnetic field at the observatory of Parc Sant-Maur. The author's conclusions from the comparisons made at the observatory above mentioned, and at the station at Valjoyeux, are that even if the actual magnetic curves can be restored by the use of amortisseurs on the machines at generating stations, this does not prevent the earth's field being disturbed by the street currents from the tramway returns. These currents, which have seriously interfered with the observations at Parc Sant-Maur, leaked from the trolley system of the East Parisian line. The author shows that the troubles not only affect the diurnal variations, but also the absolute value of the magnetic elements.

Electric Lighting Twenty Years Ago and Since.

By Professor Elihu Thomson and Mr. Edwin R. Weeks.

LOOKING back to the condition of things in the electric lighting field twenty years ago, we find the arc lighting system of Brush the chief factor. It was then being used in street and store lighting in a few cities. The circuits were of bare copper wire. About this time an effort to couple up in series seven Brush forty-light dynamos was made in Cincinnati on such bare circuits all over the city, but the result was not particularly successful, except in spoiling some of the dynamo insulation.

ELIHU THOMSON.

Weston arc dynamos and lamps began to be used in considerable numbers at that time, frequently several ten-light machines being coupled into a single series circuit of forty or fifty lamps. The arcs were of the short, hissing character, about twenty to thirty volts per lamp, and eighteen to twenty amperes on the circuit. This type of arc has long been obsolete. The factory of the American Electric Company (the Thomson-Houston Electric Company in the fall of 1882) was then at New Britain, Ct., and the first "T.-H." twenty-five-light arc machine was there built, just twenty years ago.

Currents of ten amperes and forty to fifty volts to the arc were used. The year 1882 was an eventful one for the Thomson-Houston system. A controlling interest was bought early in the year by the representatives of the Brush company, and again sold to the Lynn syndicate in the fall. The Thomson-Houston Electric Company was chartered in that year, and Messrs. S. A. Barton, H. A. Pevear and C. A. Coffin became connected with the interests.

The incandescent lamp, together with dynamos, mains, etc., in the hands of Edison, was being developed, and early in 1883 the first three-wire town distribution was started at Brockton, Mass. I visited the plant just after the beginning of its operation, and had a pleasant meeting with Mr. Edison at the station. It contained two small dynamos (then considered fairly large) coupled to the underground mains of the three-wire distribution, and everything was running very smoothly, but Edison lamented the amount of copper required in the distribution.

The arc lighting systems were not without their difficulties. Good carbons were not always to be had, and crooked ones were common. Opal globes were very thick and absorbent, while for indoor uses the ten-ampere arc with clear or ground globe was too intense. Construction of lines and apparatus was not easy, owing to lack of suitable material and labor. Copper wire without soldered joints could only be obtained in lengths aggregating a few pounds. Armature iron was of uncertain and irregular quality. Of insulating material there was little variety and often it was not high grade. Baking ovens came later. We had to construct our own measuring instruments and standards, as suitable ones were not to be bought. The plant after construction and installation was often at the mercy of poor power and unskilled attendants. These had to learn by mistakes, not always beneficial to the plant itself. Plant had to be made to take care of itself in a large measure. It is interesting to note that the man in charge of the Lynn arc lighting station in 1883, and who ran the engine and several arc-light dynamos, would lock up the station for an hour or so at a time while he was out patrolling the lines; everything in full blast. In those days all was continuous current, no alternating—at least in this country. A long history could be written of the troubles and, might I add, the triumphs of those early days. There was indeed plenty of opportunity to fail or to succeed. Is it any different now?

To attempt to span another twenty years ahead and look into the dim future of the art is a task which may well deter us. Perhaps we must look to matters which are to-day largely laboratory experiments for our guidance. We have, however, the Nernst lamp in a fairly advanced commercial stage; the mercury vapor lamp of Hewitt, and the Bremer fume arc, all promising high efficiency of light production.

The cheapening of power production will doubtless occupy future years, and possibly large gas or internal combustion engines of relatively high efficiency will be found in service. The unification of interests will go on and have the effect of preventing waste. To one whose vision carries him back over thirty or more years of progress in science and engineering achievement, the future must appear but a continuation of past progress, leading to grander conquests. Do we not still waste about ninety per cent of the energy of fuel? Is not the secret of the cold light of the firefly still ungrasped?

ELIHU THOMSON.

Lynn, Mass., January 27.

No one interested in the development of the science of electricity can view the history of the twenty years covered by the ELECTRICAL REVIEW without enthusiasm for the marvelous transformation which it has wrought in the civilized world. Night has been turned into day, and the hours of healthful, effective industry have been doubled. The generation of power has been revolutionized and concentrated, while the power itself has been widely distributed, transformed and subdivided to meet the needs of the most varied arts and industries.

EDWIN R. WEEKS.

Leaving to others the categorical enumeration of the original researches and inventions of the great pioneers in electric science and its industrial applications, and also of the brilliant achievements of those younger men, from Tesla and Steinmetz to Hewitt and Marconi, I note a few features in the history of electricity that seem to have been but casually mentioned or wholly overlooked.

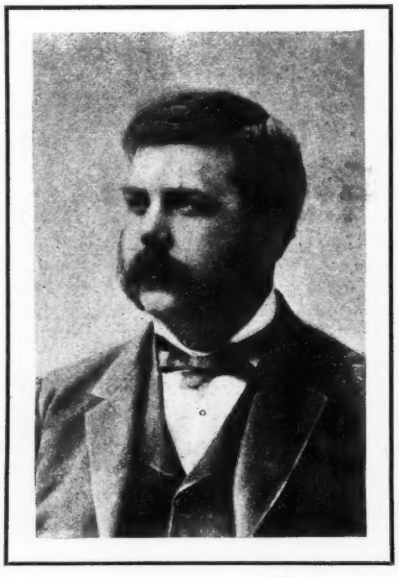
Among the forces which have contributed the remarkable progress of the past two decades stands the electrical press. Intelligent and active from the first, it gave wide dissemination to the information which drew to the new industry the millions immediately invested in its development. To the ELECTRICAL REVIEW and the *Electrical Engineer* was largely due the founding of the American Institute of Electrical Engineers and the National Electric Light Association, which have been prominent factors in the advancement of the science of electricity and the industries founded thereon.

Those of us whose connection with the business covers this period must always

remember, with deep regret for his untimely death, the founder of the ELECTRICAL REVIEW, the genial Worthington, whose big heart and boundless hospitality contributed much toward cementing those bonds of friendship and good understanding essential to the free interchange of experiences incident to the establishment of a wholly new but rapidly expanding industry. While Mr. Worthington was unable to attend the gathering in Chicago, at which the National association was formed, his spirit and counsel were present, and the REVIEW was ably represented by its associate editors, Charles W. Price and Wm. A. Hovey. The policy of the REVIEW has always been progressive, and its files furnish an illustrated record of the theoretical development, inventions and financial growth of applied electricity. Its birth antedates that of the multiple arc central station, the commercial electric motor and the successful electric railway, and was practically coincident with the commercial introduction of arc lighting, which waited upon the inventions of Brush and Thomson for its success as an industry. It is a pleasure to note that many who were pioneers in research and invention, and whose reputations have become world-wide, are still young men and are actively engaged in enterprises of great pith and moment. Edison does yoeman's service in the laboratory, Weston is at the head of the world's finest manufactory of electrical measuring instruments, and Elihu Thomson, chief electrician for the greatest electrical manufacturing company, is the same kindly professor who, as teacher in Philadelphia and as director of the first Thomson-Houston factory at New Britain, Ct., had ever a word of advice and encouragement for the humblest worker as well as for the anxious investor.

Among the original investigators, the light has gone out with those intellectual giants, Ferraris and Helmholtz, and his greatest pupils, Hertz and Rowland, but they have left with us their ardent love for science, their methods of research and the lasting monuments of their achievements. Hundreds of their pupils, breathing the breath of their life, will carry the banner of truth to still broader plains and higher altitudes.

A striking feature of the history of the past two decades is the readiness with which the new industry was financed. Usually, investments of great magnitude are difficult to secure for wholly new enterprises, but the success and convenience of the telegraph and telephone, which required comparatively small investments and were yielding handsome dividends, and which had annihilated distance and multiplied the possibilities of business, had paved the way to an almost phenomenal credence in the future of electricity.



GEORGE WESTINGHOUSE,
PRESIDENT, THE WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY.

CHARLES A. COFFIN,
PRESIDENT, THE GENERAL ELECTRIC COMPANY.

REPRESENTATIVE ELECTRICAL MANUFACTURERS.

Many arts and crafts previously greatly restricted in their possibilities suddenly found in applied electricity the means for their development for which they had long felt the need, but for which they had sought in vain. This at once created a new and world-wide demand for electricity in its various adaptations.

Again the influence, the inspiration which the personality of the great investigators and inventors exerted on the progress of electrical industries, can not well be overestimated. Their very presence created confidence in the most conservative and cautious investors, and spurred their assistants and those engaged in all parts of the field to the highest pitch of intelligent endeavor. No discussion of the financial growth of applied electricity will be complete which does not embrace the influence of these personalities.

Much credit must also be given to the captains of finance and industry who, like Westinghouse, early perceiving the real possibilities of electricity, never wavered in faith through the dark days of financial storms and doubtful experimentation, but by renewed investments carried the industry to its present commanding position.

Applied electricity has added to the work of the world many new trades, and to the learned professions a new member, ranking among those requiring the highest degree of intelligence. A new department has appeared in the curricula of higher schools and universities, and educational requirements have been rendered more definite and more practical. Thoroughness in mathematics and accuracy in all scientific studies have received a marked impulse from the exhaustive researches, inventions and practical applications in the electrical field.

Nor is it alone in the schools that these effects are apparent. All systems of thought and philosophy, and all trades and professions have felt the quickening and broadening influences of this the youngest and yet the greatest of the sciences.

Modern discoveries in electricity have necessitated the rewriting of the older sciences on broader planes and with new understanding. By its light natural phenomena have taken on new meanings, and many of the mysteries of the physical world have been made clear.

Electrical experimentation has produced such rapid and far reaching results, and has been so full of promise of new wonders to come, that it has produced a powerful effect upon all human activities. It has created an intellectual expansion without parallel in the history of civilization. The expectations to which it has given birth, and the rapidity with which they have been more than realized have inspired an unprecedented mental alertness, and have quickened into vigorous life many lines of thought which had long lain dormant. The new birth of electricity has given an impulse to the thought and to the activities of the world, comparably only with those created by the Crusades and by the discovery of America.

EDWIN R. WEEKS.

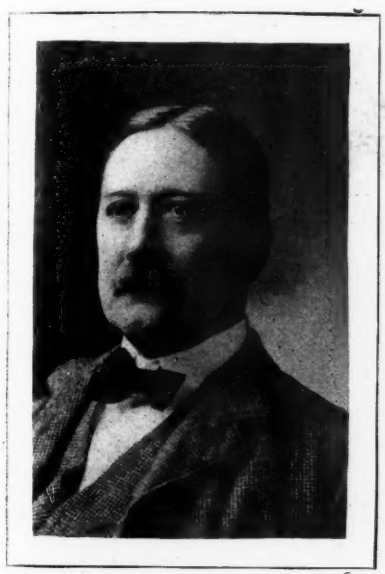
Kansas City, Mo., February 1.

The Beginnings of Alternating-Current Engineering.

By William Stanley.

I REMEMBER well the introduction of the first incandescent lamps into New York. The United States Electric Light Company operated in those days (1881) a lamp factory located on Twenty-fifth street between Sixth and Seventh avenues, and a machine shop on the northeast corner of Twenty-sixth street and Sixth avenue, over which Mr. Hiram Maxim—now Sir Hiram—presided as electrician and general wizard.

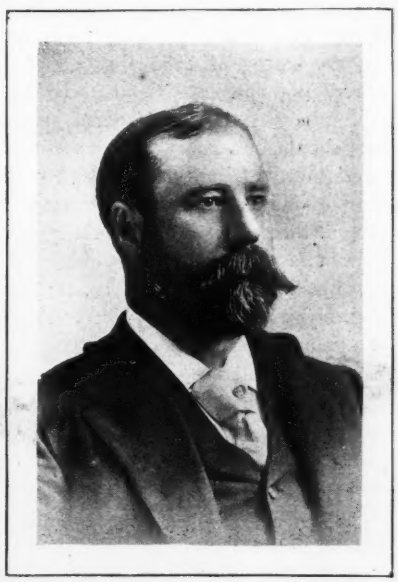
Mr. Maxim had perfected methods of manufacturing incandescent lamps, some of which have become fundamental to the art, and had succeeded in making both lamps of small and very large candle-power which the directors of the company used to exhibit to hopeful investors in the company's stock.



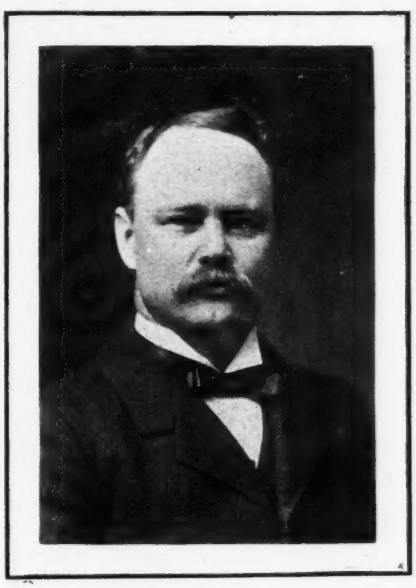
CHARLES R. HUNTLEY,
GENERAL MANAGER, BUFFALO GENERAL ELECTRIC COMPANY.

Now, one day word came from the company's main office to the effect that it was time to show the expectant public that the "system" of the company was in commercial shape and could compete with other forms of illumination in the lighting of a great city; in other words, Mr. Maxim and his staff were ordered to install six lights in the drug store of Caswell, Massey & Company, on Broadway, near Twenty-fourth street, as I remember it.

This news was received by the "staff" with great rejoicings, a quantity of bare copper wire and iron staples was purchased, the services of a ship's rigger were obtained, several dynamos were dusted, cleaned and made ready to maintain the service of the lamps, and after some little delay a wire was stretched from the roof



MARSDEN J. PERRY,
GENERAL MANAGER, THE NARRAGANSETT ELECTRIC LIGHTING COMPANY, PROVIDENCE, R. I.



ALDEN M. YOUNG,
VICE-PRESIDENT, KINGS COUNTY ELECTRIC LIGHT AND POWER COMPANY, N. Y.

FOUR REPRESENTATIVE ELECTRIC LIGHTING MANAGERS.

of the company's shop, at the corner of Twenty-sixth street and Sixth avenue, over the tops of the intervening buildings to the roof of the drug store and brought down into its premises.

Two chandeliers were then wired up; that is to say, lamps were fastened to the chandeliers, having one terminal grounded on the chandelier and the other connected to insulated wires leading to the overhead conductor.

The city gas pipes were used for the return circuit.

I remember that it fell to my lot to arrange the machinery for supplying the service. For this purpose a "No. 20" machine was employed, having a rated capacity (in the company's literature) of 100 Maxim lamps, and a Maxim automatic exciter was used to maintain a constant electro-motive force upon the wire.

SAMUEL INSULL,
PRESIDENT, THE CHICAGO EDISON COMPANY.

Strange to say, this crude installation really gave excellent results; the lamps burned brilliantly, creating a fine public impression and thereby caused an additional demand for the company's stock, and both the directors and "staff" were happy.

I refer to this very early installation to emphasize the advance in the art that has been made within the last twenty or more years, for in those days the art was confined to the Brush and Thomson arc machines, the Edison lamp, the Maxim machines and lamps, of which the public knew practically nothing and engineers substantially less.

It is true that Brush had put out his work in well finished and operative condi-

tion, that Edison had laid the sound foundations for the lamp business and that a few other men of note were coming on, but it is equally true that there was no electrical engineering knowledge, that no one knew how to correctly design a generator or motor and that most of the engineering work was pure guessing.

Soon after this time Hopkinson showed the world the three-wire system, which has proved to be one of the great advances made in the art of distributing electricity.

Weston at about this time began his memorable work on the construction of constant-potential machines, which resulted in developing the continuous-current machine to its present perfection; but there was no thought of any general and universally applicable system in those days.

After the three-wire system became known and its advantages were clearly apparent, many inventors attempted to introduce some hybrid system intermediate between the series and multiple systems, and Brush, Weston, Thomson and many others strongly advocated the use of the series-multiple or multiple-series systems as a general solution to the problem of how to distribute electricity over large areas.

In 1883, however, Lucien Gaulard brought out in London his system of operating induction coils in series, and this system of Gaulard's was far more of a system, and was much more completely worked out than the general public imagined. It was not only a system by which the high-potential currents of a generator could be used to deliver low-potential currents on local circuits, but it also contemplated an automatic regulation feature which then was and now is little understood.

Gaulard proposed to place a series of "inductoriums," or, as we should say, open magnetic circuit transformers in a line connected to an alternating-current generator supplying a constant current and showed that if the "inductoriums" or transformers were made open-circuited and had very high mutual induction between the primary and secondary coils, and if the alternating generator was constructed to give a constant current, each induction coil would give a constant potential on its secondary circuit through variations of resistance in that circuit, such as variations in the number of lamps turned on or off.

Gaulard's work was really of a remarkable character, in that it showed the comprehensive knowledge that he had obtained of the laws of the induction coil and the reactive effects occurring in alternating-current machines. But it was hopelessly ill-fitted to the conditions imposed by a general lighting system.

In 1883 I attempted to devise a system of alternating-current distribution that would be inherently self-regulating, but found that I knew too little of the subject to venture into it.

In 1884 I again took the matter up, spurred on by the work of Gaulard, but again failed to reduce my ideas to anything like practical work.

In the spring of 1885 I suggested to some of my business friends, who were much interested in the Gaulard system, that I should undertake some experiments to determine the working constants and factors of induction coils, and during the spring of that year I made several types of coils that gave me a little more insight into the subject. That summer I finally reduced my work to a coherent condition and again strongly urged my friends to take up and exploit an alternating-current system in which the transformers should be arranged in multiple arc and operated at a constant potential. My associates, however, doubted the wisdom of this advice, probably feeling that I was fully as sanguine of its success as I was entitled to be, and finally refused to devote the funds for the experimental work necessary to the undertaking.

By this time I became so satisfied of the value of the system and of the great opportunities that its development would necessarily bring forth that I determined to build a plant of my own and demonstrate the correctness of my views.

It is to be remembered that at this time, that is, in 1885, there were no alternating-current machines built in America. The only transformers or induction coils that I knew of were three or four or more of the Gaulard type that had been imported from England. They were designed for series connection, with straight open magnetic circuit cores about two feet long, and the ratio of transformation in each coil being one to one, that is to say, the potential on the primary and secondary circuits was intended to be the same.

In the fall of 1885 I hired an old disused rubber mill at Great Barrington, Mass., and set zealously to work to construct the system which was to embody the features that I deemed necessary for self-regulation and operativeness.

As there were no alternating-current machines at hand, I borrowed a Siemens machine of Mr. George Westinghouse that he had imported from England, and constructed about a dozen transformers, as shown in the accompanying figure, each of which was wound to reduce the 500-volt main-line potential to 100 volts in the secondary circuit. This work took me most of the winter of 1885, and it was not until along in the spring of 1886 that the generator was set up and connected, the transformers were completed, tested and erected in some of the stores of the village of Great Barrington, where they were put into service on a regular commercial basis.

Crude as the apparatus was, with all its faults of design and construction, it operated in a marvelously beautiful manner, and thoroughly satisfied me that I had a system of distribution which was capable of indefinitely extending the limits over which electricity could be publicly served.

It is worthy of note that this system, which was normally operated at 500 volts primary potential, reducing to 100 volts secondary pressure, was also operated on the double conversion system. The 500-volt primary electro-motive force was transformed up to 3,000 volts, from 3,000 volts back to 500 volts, from 500 volts down again to 100 volts upon the secondary or distribution circuits.

As I look back on the plant now I tremble for the safety of the inhabitants of Great Barrington while these experiments were being tried. We did not have oil insulation or oiled cloth in those days, but separated our primary and secondary circuits with shellaced paper and various other substances of an equally fragile nature; but all went well with the system, no accidents occurred, and no dangers, other than a small fire, were reported until an attendant dropped a screwdriver into the armature of the Siemens machine and entirely ruined it.

Early in April of 1886 Mr. Westinghouse, with some of his friends, visited Great Barrington and inspected the plant. The results of this visit soon took form in the development of the Westinghouse Electric Company which installed the first alternating-current station in this country after the Great Barrington plant, at Buffalo in the fall of the same year.

My tests on the Great Barrington apparatus in the fall and winter of 1885 convinced me that, as then constructed, the Siemens machine was entirely unfit to furnish a variable current at a constant potential and, as there were no machines designed for this purpose in those days, I determined to build one.

After some study I designed the machine shown in Fig. 2, which is a copy of a photograph of the original alternating-current machine built for me by the Westinghouse company. If the operation of the Great Barrington plant successfully

proved the practicability of the alternating multiple arc system, I think I may say that the tests of this alternating-current machine were as remarkable, in that they laid the foundation for the building of alternating-current generators in this country. My alternator was designed to give a potential of 500 volts with the minimum possible drop of pressure between no load current and full load current.

When the machine was finally constructed and set up for test by the late Mr. Shallenberger, I went on to Pittsburgh to witness its performance and was much delighted with my work when it was found that, at the predetermined speed and exciting current, the electro-motive force of the machine was 490 volts instead of 500 and fell off less than five per cent when the load was increased from one lamp to full load.

FIG. 2.—MR. STANLEY'S FIRST ALTERNATOR.

It is remarkable how little of modern electricity we all knew in those days. The terms inductance, mutual induction, self-induction, armature reaction, transformer, converter, single-phase, multiphase, hysteresis and a number more were unknown. When we saw phenomena that we did not understand we had to try and fit some sort of names to them. I called my Great Barrington induction coils "converters" for want of a better term, and well remember that when I spoke to the late Mr. George Prescott regarding the ohmic resistance of a circuit, he turned to a friend and asked him how many kinds of resistance Stanley carried around in his pocket.

In those days the late Franklin Pope was chief legal adviser of the Westinghouse company. Mr. Pope was brought up with a telegraphic education and consequently had some notions regarding the kicking back properties of coils as found in his profession.

Now, one of the principal difficulties that I had in those days was to make Mr. Pope understand that there was something in the nature of an opposing force developed in the primary coil of a converter when it was connected to an alternating electro-motive force, the troublesome factor, in Pope's mind, being the failure of Ohm's law, for although an electro-motive force of 500 volts was applied to a coil of only one ohm resistance, and consequently 500 amperes of current ought to have flowed by law; yet, as a matter of fact, but one-tenth of an ampere escaped the circuit.

I well remember how, when Mr. Pope finally understood my explanation of the

FIG. 1.—THE FIRST TRANSFORMER EVER BUILT IN THE UNITED STATES.

counter-electro-motive force developed in the primary of a coil, and how this electro-motive force could be varied by the demagnetization of a secondary current, I well remember, I say, how he rocked himself to and fro and kept saying: "Great, great. You've got it," and posted off down to Pittsburgh to convince his people that there was really something in the alternating-current idea.

It was some years later before the art was ready for high-potential work, for it was necessary that the alternating machines, the transformers and the system devices should attain a certain degree of perfection before engineers dared to introduce the idea of serving electricity over great distances by means of very high potentials, as the profession understood that term.

It was the courage and nerve of my associates, Messrs. Kelly and Chesney, however, that finally inspired us to open up the limiting condition of the alternating system by devising transformers for very high-potential service. Early in the nineties, at Pittsfield, Mass., several transformers for raising the potential of our alternating machines from 1,000 to 10,000 volts were constructed and a pole line connected to this high-pressure service was erected upon the estate of Mr. Charles Atwater, then president of the Stanley Manufacturing Company.

This high-pressure system was served

from the local lighting station of the city and operated throughout the greater part of a Berkshire winter.

We wanted to find out whether or not an overhead line having 10,000 volts impressed upon it would or would not break down during the climatic changes of a Berkshire winter.

In the hands of Messrs. Kelly and Chesney this work has progressed to a marvelous extent, until to-day we find a system upon the Pacific coast operated at 60,000 volts pressure, successfully transmitting thousands of kilowatts over a distance of 220 miles. When one realizes that it is possible to-day to transmit with fair efficiency from a single station over a territory of 200,000 square miles area, or, to put it in another way, over a diameter of 500 miles extent, and realizes that only six such stations would be required to serve the entire country from the Atlantic to the Pacific Ocean throughout a belt of 500 miles wide one may well think that the alternating-current system has approached the limits of its serviceable expansion, but I am convinced that, while the extension of the territorial limits covered by the system need no longer demand the study of the engineer, we will expand its use enormously by the perfection of the apparatus employed and by the employment of new principles and methods of generating our currents.

I feel confident that a more direct application of alternating current to traction work will soon engage our attention, and feel that twenty years from now, should the ELECTRICAL REVIEW invite some of its friends to discuss the history of the past, they will still be able to report lines of progress and development as remarkable as those that we have witnessed since its first birthday.

Some Personal Notes on Electric Railways.

By Frank J. Sprague.

THE years 1887 and 1897 are epochal in electric railway history. In one was made the contract for the Union City Railway, of Richmond, the prototype of modern trolley roads, and in the other that for the South Side Elevated, of Chicago, the first application of the multiple-unit train system.

The first has pioneered an industrial development of almost unequaled magnitude, and the second has solved the problems of urban and suburban electric train operation, and challenges the steam railway in its own territory.

Both contracts were undertaken under the same responsibility, and violated ordinary commercial prudence; each was founded largely upon undeveloped and untried ideas, and was bitterly opposed and ridiculed; yet both, although at great immediate financial loss, were carried to successful issue.

When the Richmond work was undertaken there was not a dozen electric railways in the world. Scarcely any two were alike, and not one formed a precedent. Some blue-prints, a few experimental machines, a superabundance of confidence and youthful energy, and a limited amount of cash formed both capital and reserve.

The contract called for the complete equipment in ninety days of a road, at that time not constructed, with a number of cars and motors nearly equal to the aggregate of all other roads combined, and on a system largely novel. Of the forty cars, thirty were to be operated at one time from a 375-horse-power station, on grades greater than had ever been attempted by a self-propelled car, and with a guarantee of economic performance declared impossible of accomplishment.

My assistants were Lieutenant Oscar T. Crosby, who early achieved distinction, and Ensign S. Dana Greene, whose recent sad death ended a fine career. Both were new to the work, but possessed pluck, enthusiasm and endurance.

On account of illness I got my first disappointing sight of the road in the fall. The track was execrable, a twenty-seven-pound rail, loosely jointed, laid in Virginia clay. There were grades and curves the equivalent of twelve per cent. Twenty-nine curves, five of less than thirty feet radius, did not add to the attraction. Part of our work had already been progressed, but I knew at once that we would have to begin much of it all over.

The general characteristics of the system are now familiar. A small overhead trolley wire was reenforced by a main conductor supplied by feeders from a central station. The return circuit was by the rails bonded together and to a continuous conductor connected to ground-plates and to the water and gas systems of the town. Four hundred and fifty volts was adopted for the working potential, and the motors were to be operated on the multiple-arc system. These had single reduction gears, and were carried under the car, centered on the axles and flexibly suspended on the plan now almost universally adopted. They had fixed brushes, were operated from rheostatic series-parallel controllers at each end of the car, and were left entirely open. Almost every one of these details, since become standard, was then novel, and saw its first application to railway practice at Richmond.

The ascent of even an eight per cent grade by a car depending only upon rail adhesion had been declared impracticable, but a much greater grade faced us. So after some anxious debates over an electric cable adjunct, we ran out our first car one night with a picked crowd of fighting men made necessary by the exigencies of a political celebration. Sharp curves and the heaviest grades were successfully negotiated, and although roasted machines, crossed armatures, a derailment and collision, with a final retreat at the tail of four able-bodied mules were added to the night's experience, the critical question of adhesion and hill-climbing had been settled, and we were left to ponder over ways and means.

Meanwhile our single gears had to be abandoned, and double reduction gears supplied. With the help of the Brown & Sharpe Company this trouble was met, but this was but the beginning of difficulties. The field magnets were wound in sections, the insulation was crude, and the work hastily done; in consequence, grounds and crosses were frequent. Probably not less than fifty styles and modifications of trolleys were designed, and a large number tried before the universal movement type was adopted. The overhead construction at curves and the switches at turnouts had to be developed to correspond.

Then there were serious financial troubles, with consequent contract concessions made necessary because of our delay and a "sixty-day satisfactory operation" clause. The cost had already been grave, and much more was to come, yet it was no time for whimpers or hesitation, for these spelt professional and financial ruin.

The road opened for regular service in a drizzling rain about the first of February, 1888. The day was one of disappointments, for car after car would balk with locked gears. These would then

have to be removed, and the car either pushed along or bodily lifted from the track.

One of the most exasperating troubles was with the commutators. The armatures were double-ended, had a commutator at each end, cross-connected so that but one top brush on each commutator was used. One of the pair would blister and burn in a disastrous manner, actually frizzling the mica. When this trouble was reduced by changing the method of reversal, there remained plenty more at the brushes, due to the shifting of the neutral point under various loads and to the character of the brushes themselves. Not only did every machine on the road have its fields and armatures rewound, but every commutator was replaced by new styles and makes.

Before the final adoption of carbon there were a great many kinds of brushes tried. At first these were flat ones, both solid and laminated, which would quickly wear through, bend over and form an arc around the commutator. Then oblique solid and laminated brushes, which would catch in the bars when reversing, and split and straddle perhaps half a dozen bars, with the result of ruined commutators, crossed armatures and burnt-out fields.

Tilting brushes were also tried, and then many varying shapes of copper, bronze and brass set on end and backed by springs, and even solid bars of bronze, at a resultant cost which would have paid a fair dividend on the cost of the equipment, and which lined the street with a shining trail.

The number of disabled machines was something appalling, and to keep the road in operation two factories, our own in New York and that of the Edison company in Schenectady, were heavily drawn upon, and armatures and machines constantly forwarded by express.

Despite these difficulties, however, and many others unmentioned, the number of cars in operation was steadily increased, and three months after the opening, during which period of struggling advance not a car had been pulled by animal power, the opportunity arose to test the capacity of the equipment by putting thirty cars into operation. Our boilers took care not only of the railway load, but also of a very considerable amount of lighting, and the highest average reading on the line was less than three-quarters of the normal capacity of the dynamos. This test was particularly interesting because circulars in favor of series operation were then extant which condemned the multiple-arc distribution, and stated that twenty cars operated on this plan would require about fifteen times the power actually used or in trial. Whatever the past fatigue, worry and trials, they were for the time being at least forgotten. Soon after, the assembling of a lot of cars at night, and then starting them off one after the other from in front of one of the local theatres was the cause of almost equal exuberance.

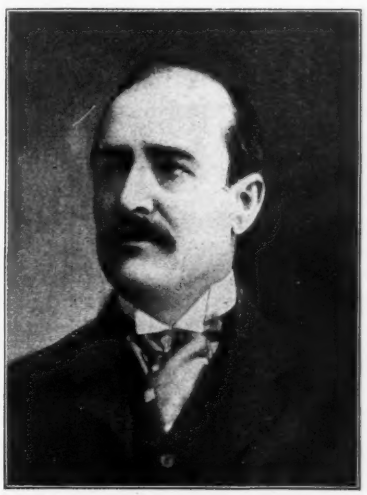
About this time President Henry Whitney of the West End Railroad of Boston, who had almost concluded to introduce the cable on his lines, came to Richmond, accompanied by some of his directors and his general manager. The latter was sceptical about moving a number of cars if banked. Our car-house was the open street, the roof the canopy of heaven. It was located at the end of a loop whose wiring capacity had been calculated to take care of about four cars with economic drop. Determined to make the trial, about midnight I roused Mr. Whitney from bed, and started for the end of the line. I had previously warned the engineer to raise the potential to 500 volts, to reenforce the feeder fuses, and to hold on no matter what happened. He did so, and at the wave of a lantern twenty-two motormen started their cars as rapidly as headway could be obtained. The potential dropped to low ebb, but that mattered little, for that line of cars was underway. This experiment was conclusive, and it settled the fate of the Boston cable.

The incidents characterizing the operation of the Richmond road would fill a large volume. Many were of a most disheartening kind, and yet others were of a character which put every one on keenest edge, and gave a zest to the work which no ordinary enterprise can afford.

Prolific as were the experiences, many were incident to local conditions. There were no guard rails on the curves, and no paving, so the cars would frequently follow their natural tendency to tangent, and bury their wheels in the mud. Soon they looked like the advance cohorts of an ancient attacking party, for to lift the cars back on the tracks there were provided timbers which looked like battering rams, scaling ladders to reach the roof to fix the trolley, and electric "kedges" to make connection between the wheels and the rails when the cars were entirely off the track. Military and nautical resources were naturally called upon, as well as the

WALTON H. HOLMES,
PRESIDENT, THE METROPOLITAN STREET RAILWAY COMPANY, KANSAS CITY.

H. H. VREELAND,
PRESIDENT, THE METROPOLITAN STREET RAILWAY COMPANY, NEW YORK.



J. M. ROACH,
PRESIDENT, THE METROPOLITAN STREET RAILWAY COMPANY, CHICAGO.

THREE REPRESENTATIVE STREET RAILWAY MANAGERS.

good nature of the traveling public, who were often asked to help boost back their lame conveyances.

Sleet and ice caused some anxiety, and on one of the worst nights in the winter I had temporarily suspended the contest. The morning found the trees pendent with icicles, and the trolley wires covered with a glistening shield. The road was absolutely shut down, and electric traction looked dubious. I had left over night in front of my hotel a small construction car having the euphonious name of "Snowflake." Mounting this in the morning, after finding the current was on the line, I managed to make occasional contact with the trolley, and after mopping off the snow from the terminals of the machines, started down hill on a tour of exploration. Arriving at the top of a ten-per-cent grade, my eyes were gladdened with the sight of a trolley car just mounting the hill, on the top of which was Pat O'Shaughnessy with a large broom with which he was vigorously pounding the trolley wire, while the ice, in a shimmering shower, fell to the street. We resumed operations with a fairly light heart.

Thunder-storms were severe in Richmond, and we awaited the first attack with apprehension. The long overhead circuit was entirely unprotected by lightning arresters, and there were numerous ground connections through the motors and lamp circuits which invited constant discharge. The line was frequently struck, the discharge often passing through the lamps and shattering the carbons, after which we learned to turn on the lights during a thunder-storm. Sometimes the discharge would go to ground through the motor fields, and again the grounding would take place at a controller. Our men soon got used to it, and paid little attention to these heavenly manifestations, but the colored population when sitting on the rail would find a lightning discharge alongside of them rather too much for their equanimity. Choke coils were soon installed on the cars, and various kinds of lightning arresters devised, but the fluid proved somewhat erratic and beyond our positive control.

As if electrical troubles were not all-sufficient, on this road began the telephonic interferences due to the practice on the earlier lines of using grounded circuits, resulting in legal contests throughout the States, with eventual victory for the electric railway, and the adoption of metallic circuits by the telephone companies. Thus did we become public benefactors.

Richmond, however, has passed into history, yet the path it blazed now leads the world over. Along its iron way tens of thousands of cars, propelled by hundreds of thousands of horse-power, safely carry their millions of passengers. The electric railway has already become a mighty force which has changed our physical and social conditions, and turning from the nightmares of the early past prophets look forward with confidence to the larger problems of railway operation.

The multiple-unit development of 1897-1898, in Chicago, was less dramatic from the public standpoint, because it took place at a later period, when the novelty of electric railways had disappeared. Nevertheless it was fundamental, and marked the beginning of a new departure now endorsed by general adoption.

For a long time I had vainly sought, on the Manhattan Elevated Railroad, of New York, the opportunity to make at my own expense a demonstration of the possibilities of the multiple-unit system, that is, the operation of a train composed of a plurality of independent units under common plural electric control. At last, in April, 1897, I was called in consultation to pass upon the plans for electrifying the South Side Elevated Railway, then operated by steam.

Just recovering from a serious accident, and about to go away, I was at first reluctant to take up this additional work. But on learning that the engineers were Messrs. Sargent & Lundy, the latter of whom had been with me at Richmond, I consented to do so, postponed my trip temporarily, and agreed to briefly pass upon the plans.

I immediately saw the opportunity to put into operation my pet ideas, which, having been explained to the engineers, received their hearty endorsement. After making my report, I offered to support it by a personal contract to put the system in operation. The decision hung fire for a few days because of the radical nature of the proposition and the opposition of the leading electric companies, although it is but just to say that from the first I had the personal support and good will of Mr. William J. Clark, who saw the commercial possibilities of the new development in the field he had done so much to advance. The contract finally awarded, but signed only after my departure, was, it is almost needless to say, very much like that for Richmond, for realizing the gravity of the proposed departure in practice the requirements were of the most rigid character, and the conditions under which the equipment was to be installed most exacting.

In addition to a penal bond of $100,000, and the obligation to at once start upon the equipment of 120 cars, including their alteration, and the supplying of trucks, motors, brake compressors, and an entirely new system of train control, six cars were to be completely equipped ready for operation and test within three months, the test and the manner of its making to be prescribed by the officers and engineers of the road. If unsatisfactory to any of them, or if not concluded by the time set, the right of contract cancellation remained with the company. Even if satisfactory, another test of twenty complete equipments under service conditions was to be conducted likewise to the satisfaction of the company's officers and engineers, with the right still to cancel the contract without recourse in case of dissatisfaction.

The details of the controlling system were specified for a fulness of performance more than covering the most complete up-to-date practice. The car changes and the installation of the system had to be carried on on a road already in operation by steam without interference with the existing regular service.

The first test cars were ready at Schenectady only one day behind time, the train ten days later, and the second test was inaugurated in Chicago in November. By April, 1898, cars were put into regular service, and by the middle of summer steam operation was entirely abandoned.

The time, perhaps, has not come, nor does space permit the personal history and details of development of the South Side Elevated equipment, but it is proper to point out that the multiple-unit system, ridiculed and attacked in 1897, and for a considerable period thereafter, just as the Richmond road was attacked in 1887-1888, has been bodily adopted by its opponents, and has now become the standard for urban and suburban service wherever electric train operation is required.

Save on the South Side Elevated, there was little active work done for nearly two years, but now, only five years after the signing of the original contract, not only is the multiple-unit system, with varying details, being promoted by the principal electric manufacturing companies, but contracts for nearly 300,000 horse-power of equipment give practical evidence of the growth of this idea. It is safe to say that much of the great development of the near future will be carried out absolutely on this plan, and not only will it be applied to the operation of passenger cars grouped together into trains, but also to locomotive units combined to form larger units for handling trains otherwise not electrically equipped.

Telephony Twenty Years Ago and To=day.

By Thomas D. Lockwood.

I HAVE now before me Volume I of the New York *Review of the Telegraph and Telephone,* a journal from which the ELECTRICAL REVIEW of the present time was developed, or, as we may truly say, evolved. The first number is dated February 15, 1882, and, among other matters, contains a story of questionable authenticity about successful experiments in telephonic transmission through 300 miles of submarine cable; a brief account of Professor Bell's modification of the Hughes induction balance by means of which it was hoped to determine the position of projectiles in the body of a person who had been shot; a not very long article concerning the multiple switchboard; another, descriptive of the glow-lamp illumination of the London and Brighton express, the current being generated by a battery of the Faure accumulators, and a rather more complete story of the early Edison experimental electric railway at Menlo Park.

Looking through the entire volume, the wide-awake observer is bound to note an abundant promise in the electrical future, while at the same time there is nothing to foreshadow the tremendous realizations which within two decades have been attained.

A readable article could easily be written, taking account of these advances in all of the several branches of the industrial applications of electrical and magnetical science, but the ELECTRICAL REVIEW has called for a short article. The story of but one of these applications is bound to be a long story, and I will therefore speak in the main of telephony alone.

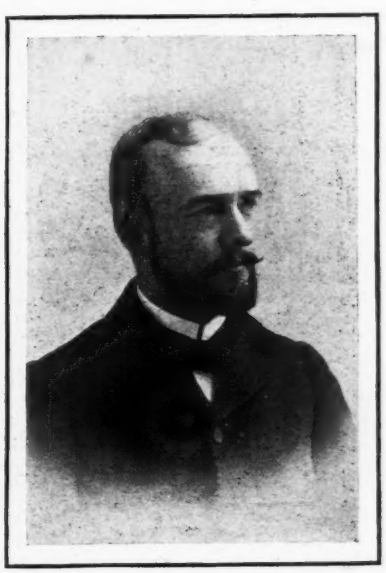
What of telephony? The writer of these words has frequently found occasion for surprise at the short memory of many persons who, seeing the telephone business what it is to-day, with its owned and substantial headquarters and other buildings, its subterraneous conduits and cables, its highly organized multiple switchboards with automatic signals and centralized universal source of current, its tremendous city-linking system of long-distance lines, and its effective engineering and technical departments seem to have totally forgotten the time of the early annual convention, when, to paraphrase holy writ, there were no standards and every man did that which was right in his own eyes. At the time of the advent of the ELECTRICAL REVIEW there were no telephone wires underground, save in the sewers of Paris; cable making was a new art; the metallic circuit was an exception, thought to be too costly for general use; there were only three multiple switchboards in the world, and these of crude character; the magneto bell and generator were estimated as an ideal means of signaling; the granular carbon transmitter was being talked about; 592 telephone exchanges and 50,000 miles of telephone wire were in operation within the United States, and the total number of telephone transmitters and receivers in use was 189,374.

But the growth of twenty years tells a wonderful story indeed. Think of the finished and scientific processes and modes of procedure which have been substituted for the rule of thumb methods characterizing the early era of telephony when we were feeling our way; think of the real estate and the commodious and permanent office and exchange buildings that have necessarily followed in the train of the subterranean conduits and cables which in all of our large cities and many of our small ones have come to be considered the only construction worthy of the name. Then, too, the selective signal question has been thoroughly threshed out; the multiple switchboard has been transformed from its chrysalis stage of serially connected jacks combined with old-fashioned call annunciators into a glorified and thoroughly efficient apparatus, taking up far less space for a given number of lines, but arranged with switch sockets in parallel and electric lamp signals governed by automatically controlled relays, and the generator and local battery of the subscriber's station has (for large installations at any rate) disappeared, and has been succeeded by a universal battery at the central station furnishing current for the transmitters of all subscribers' stations, and for the operation of the central signals in response to the simple action of taking the substation receiver from its hook and replacing it.

The telephone which, during its earliest year or two, was regarded as a toy, had by February, 1882, reached such rank in its exchange application as to be regarded as a promising industry, and as a convenient means of communication for short dis-

UNION N. BETHELL,
PRESIDENT, CHESAPEAKE AND POTOMAC TELEPHONE COMPANY AND GENERAL MANAGER, NEW YORK TELEPHONE COMPANY.

FREDERICK P. FISH,
PRESIDENT, THE AMERICAN TELEPHONE AND TELEGRAPH COMPANY.



EDWARD J. HALL,
VICE-PRESIDENT AND GENERAL MANAGER, THE AMERICAN TELEPHONE AND TELEGRAPH COMPANY.

THREE REPRESENTATIVE TELEPHONE MEN.

tances, and it was already to be seen that the granular carbon transmitter would find its field on longer lines, should such longer lines be ever constructed and operated. But lines longer than, say, fifty miles were thought to be so far in the future as to require no great amount of present thought. Yet within two years we saw an experimental line between New York and Boston spring into existence and prove workable, followed by many circuits between New York and Philadelphia, a commercial line between New York and Boston, a New York and Chicago line, a Boston and Chicago line, and from that time to the present a constant succession of additions constituting a real system of real long-line telephony.

This article does not and can not undertake to recite all of the practical improvements which have been introduced into exchange telephony, or even all of the most important ones; it can refer only, and that in the briefest and most general way, to the broad line of advance; but it would be incomplete did it not mention the one feature in which apparently no practical development has been made. Several years ago I wrote a series of papers on telephone relays or repeaters calling attention to the fact that there was no such thing, reciting the difficulties in the way, and stating the reason why, in my opinion, we had no right to confidently expect that such a device would be produced. It is, perhaps, eight years since then, but though many forms of telephone repeater have both before and since that time been devised and patented, there is still no sign of a practical telephone repeater capable of producing results constituting any improvement over the results which on lines of equal length can be produced without it.

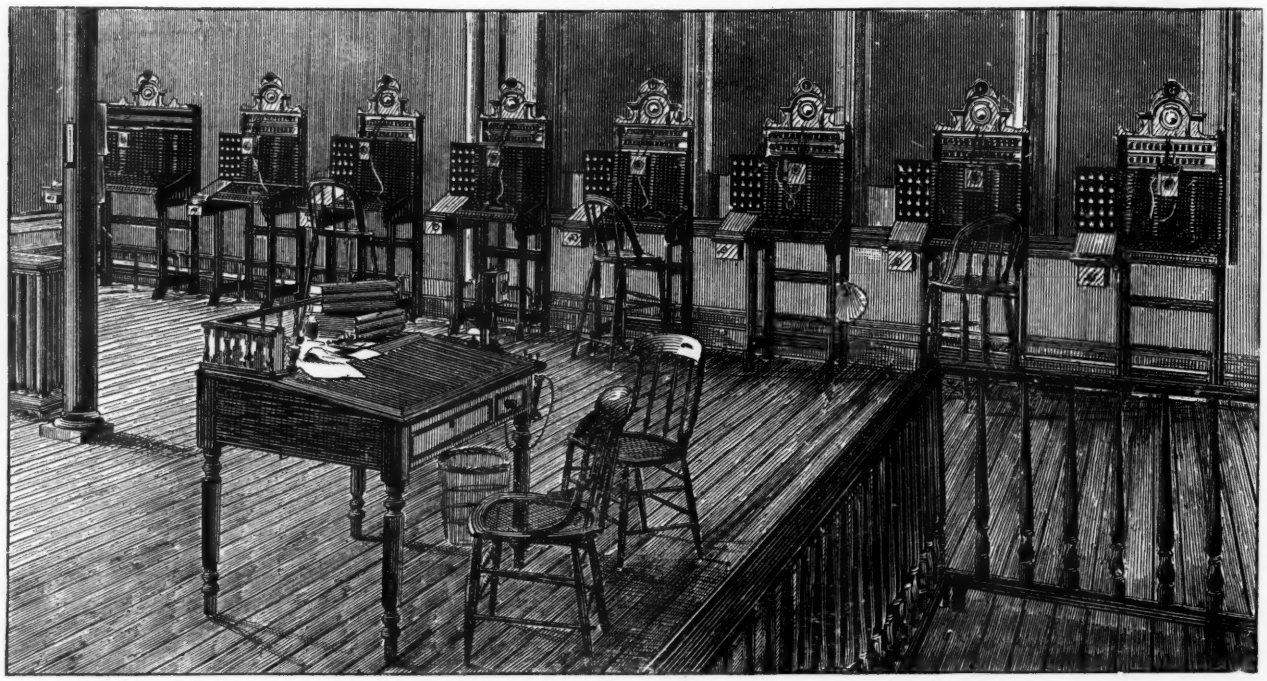
But in the two decades of ELECTRICAL REVIEW life, the 592 Bell telephone exchanges have increased to 1,500; the 50,000 miles of telephone wire have expanded to a million and a half in the Bell telephone interest alone; upward of two million Bell telephone instruments are now continuously operated in place of the 189,000 of twenty years ago, and about two thousand million conversations are daily carried on over these lines by means of these instruments.

Considering that a host of competitive telephone exchanges and a correspondingly large number of instruments are also an important commercial and social factor in daily civilized life, and that all this is in the United States alone, we can form in some sort a realization of the revolution which has quietly occurred during these years in our modes of transacting business and in communicating with one another.

In a final word on the telephone exchange let me call attention to the measured service system of charging, which is to such a marked degree superseding—where the conditions are appropriate—the flat rates which in 1882 were nearly universal. Everybody, or nearly everybody, used to think the flat rate was all right, and that language was being accurately employed when we spoke of "renting a telephone," but many of us have learned to believe that the "call," not the "instrument," is the unit of telephone exchange work; that selling service, not renting telephones, is the true business of the exchange, and that whether a flat rate or a so-much-for-so-many-calls rate be adopted, the traffic is the thing to be considered, and the service is the thing which is bought and sold.

I am no advocate of that perverted patriotism which, in season and out of season, insists on glorifying the commercial, scientific and technical performance and outlook of the United States and its people at the expense of all other nations of the world; nor have I any sympathy with national Jack Hornerism, wheresoever, whensoever or by whomsoever manifested; but I think it only fair to say in conclusion that my firm conviction is that much of the rapidity, effectiveness and immensity of the practical progress which has been made and which, in this country, has been so particularly noticeable, not only in the art of telephone and telephone exchange appliances, engineering and practice, but also in the sister applications of both branches of electrical illumination, the transmission of power and the electric propulsion of vehicles, both by direct and alternating currents, is due in part to the faculty of making and using labor and time-saving inventions necessarily brought into abnormal play by the settling of an already highly civilized race in a savage country, and carried forward by heredity, in part to a highly vital atmosphere fostering a spirit of inquisitive and utilitarian restlessness, and in part to an enlightened patent law offering great reward for great achievement.

From the beginning of our patent system up to February 15, twenty years ago, there had been granted United States patents on subjects relating to electricity and magnetism to the number of 4,697. But during the next twenty years—that is, from February 15, 1882, up to December 31, 1901—38,934 United States patents on inventions involving the employment of the same two forces have been granted; nearly nine times as many in the last twenty years as were issued in the preceding half century.



ONE SIDE OF THE OPERATING ROOM OF THE PROVIDENCE, R. I., TELEPHONE COMPANY'S EXCHANGE.

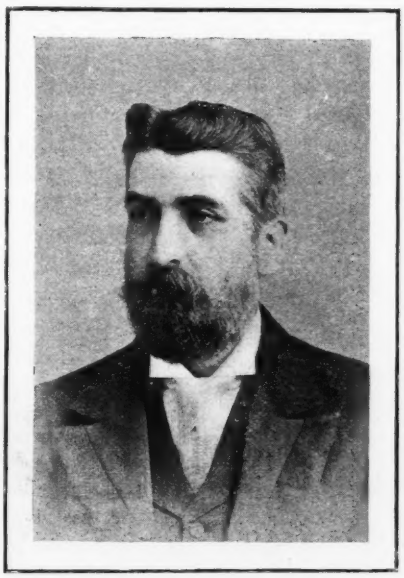
Reproduced from the ELECTRICAL REVIEW of May 10, 1883.

The Pacific Ocean Cable.

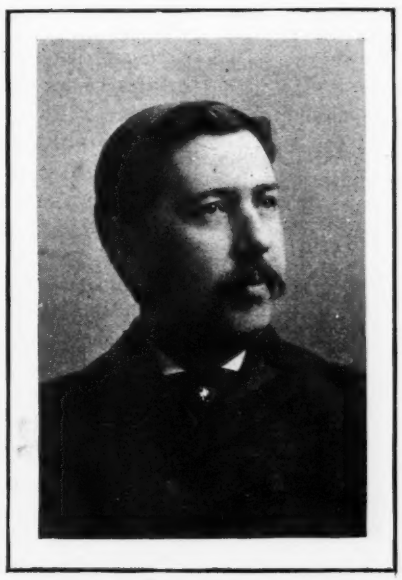
It is estimated that there is invested in ocean cables the good round sum of $400,000,000. The enterprise of the men who have laid the cables and the demand of the civilized world for this service made it possible for these great investments to become of value.

This article, however, is not intended to describe the cables of the world, but more particularly to speak of the latest cable enterprise that is attracting the attention and interest of every one, *viz.*, the laying of the cable in the Pacific Ocean from San Francisco to the Philippines.

On this page is presented a photograph of Mr. Geo. G. Ward, the vice-president and general manager of the Commercial Cable Company, and one of the most active and able cable men of the day. In respect to the laying of the Pacific cable, Mr. Ward represents the Commercial Pacific Cable Company, as vice-president and general manager, of which company Mr. John W. Mackay, probably the largest individual cable owner in the world, is president.



GEORGE G. WARD,
VICE-PRESIDENT AND GENERAL MANAGER, THE COMMERCIAL CABLE COMPANY.



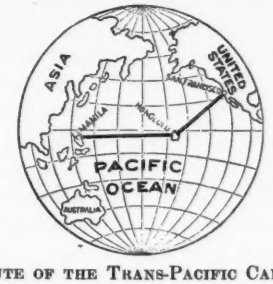
W. H. BAKER,
VICE-PRESIDENT AND GENERAL MANAGER, THE POSTAL TELEGRAPH COMPANY.

REPRESENTATIVE CABLE AND TELEGRAPH MANAGERS.

This company, with an authorized capital stock of $3,000,000, with great enterprise, has planned to lay a cable from San Francisco to Honolulu, and from Honolulu to Manila, as shown on the miniature map on this page.

Mr. Mackay wrote to the Hon. John Hay, Secretary of State, on August 22, 1902, as follows:

I beg leave to state I wish to lay and operate a submarine cable or cables from California to the Philippine Islands by way of the Hawaiian Islands, by means of an American corporation to be organized hereafter. I ask no subsidy or guarantee in connection with the same. Before proceeding, however, I respectfully write to ascertain the conditions upon which such cable may be landed at the various points under the jurisdiction and control of the United States. The same conditions that have been prescribed by the United States in connection with the landing of Atlantic cables owned by domestic corporations will be satisfactory to me in connection with this proposed enterprise. I do not ask and shall not expect the United States Government to ensure or indemnify me against any existing landing rights of any company or companies in respect to the Philippine Islands or any other islands in the Pacific. If the conditions should be substantially the same as those upon which the United States Atlantic cables were landed and if the same should be indicated to me without delay, I would arrange immediately for the manufacture and undertake to have the first section between California and the Hawaiian Islands completed by September, 1902, unless prevented by *force majeure*. I trust this application will receive prompt and favorable consideration, as it is the intention to reduce materially the tariff between the United States and the Philippine Islands, China and Japan. Mr. George G. Ward, vice-president of the Commercial Cable Company, will take pleasure in calling upon you, soon after the first of September next, should you require any further information on the subject.



ROUTE OF THE TRANS-PACIFIC CABLE.

I am, sir, yours obediently,
JOHN W. MACKAY.

The announcement of this intention on the part of Mr. Mackay and his associates has already caused a reduction in the cable rate from New York to the Philippine Islands. In September last the rate was $2.35 per word; this has been reduced by the European cable companies to $1.66 per word.

It is announced by the Commercial Pacific Cable Company that the rate it will charge from San Francisco to China will be $1 per word; from San Francisco to Manila $1 per word, and from San Francisco to Honolulu fifty cents per word; this last rate, however, to be reduced to thirty-five cents per word when the entire length of cable is completed.

In a recent statement the Commercial Cable Company announced its position as follows:

This cable company agrees to furnish all the money, purchase and lay the cable at the smallest cost consistent with first-class work; utilize the most experienced and expert cable talent; take the risk of breakdowns and failures of the cable to work; take the risk of the business not paying; give the government the right to fix its own rates for government business, and finally this cable company agrees to reduce the public rate to Manila and China to $1 per word. And then, after taking all these obligations upon itself, the company gives the government the option to take over the cable at any time at its appraised valuation. The Commercial company can construct this cable for about $12,000,000. Government construction would probably cost $20,000,000, and even then the cable might not work on account of bad construction or the vast ocean depths to be encountered.

From the above interesting facts it is fairly safe to believe that the Pacific cable will soon be laid by the Commercial Pacific Cable Company. Whether the United States Government will decide to erect a cable in competition or not is for the future to disclose.

It will be seen that the cost of the cable is estimated to be $12,000,000; the contract has already been let for the first section of the cable, between San Francisco and Honolulu, which will cost $2,224,226; this price being simply for the cable from shore to shore and does not include the shore connections, cable-ships, cable-houses and other necessary expenditures on shore.

Some Twentieth Anniversary Greetings.

Complimentary Words from Old-time Friends of the "Electrical Review."

FROM ONE OF THE FIRST MANUFACTURERS OF TELEPHONE APPARATUS IN THE UNITED STATES.

To the Editor of the Electrical Review:

As an advertiser and reader of the Electrical Review for a score of years, I take this, its twentieth birthday, to note an old-timer's observation on the electrical situation since 1878, the year the telephone began to be heard and not seen.

A year or two later came the electric light, and with it the storage battery of the Frenchman, Faure, brought over from France in 1880, and was the first electric motive power used on a car to propel it. This car was built for a Baltimore company, the Electric Storage Company.

About this time Daft was experimenting with his track conductor and motor. The writer visited and rode upon his car at Greenville, N. J.

The expansion of the electric railway motors from that time to the present has eclipsed one's most sanguine expectations.

When I observe the enormous electric motors moving the heaviest freight trains in the Baltimore & Ohio tunnel in Baltimore, my thoughts revert to 1849, when an operator in Professor S. F. B. Morse's residence, at Poughkeepsie, and I wonder what that great inventor would say were he to rise up in this generation; without doubt he would repeat his first message: "What hath God wrought."

A. G. Davis.

Baltimore, January 29.

SOME KIND EXPRESSIONS OF GOOD WILL FOR THE "ELECTRICAL REVIEW" AND ITS STAFF.

To the Editor of the Electrical Review:

As a former member of the family, I can not possibly let the fifteenth of February pass without sending my sincerest congratulations to the oldest electrical weekly in the United States.

To look back upon twenty years of incessant good work is a record of which few technical journals can boast. For the Electrical Review this is indeed a proud achievement, which can best be appreciated by those who have followed from the start the painstaking labor which has led your journal from a small beginning to the prominent place which it now occupies among its contemporaries.

While it would be difficult to state definitely to what extent the wonderful progress in the various branches of applied electricity is due to the publicity and encouragement given inventors and manufacturers by your valued paper, it is certainly but a well merited acknowledgment to state that not a small share of that progress must be attributed to the captain who has steered the ship and the men behind the guns of the Electrical Review.

It is the sincere hope of one of your well-wishers that the Electrical Review, with a past record so pregnant with good work, may live to celebrate its centennial, constantly attaining a higher level of usefulness for the electrical fraternity, a trusted counselor and leader in the van of electrical science.

Victor M. Berthold.

Boston, January 29.

REMINISCENCES FROM ONE OF THE PIONEERS OF THE ELECTRIC LIGHTING INDUSTRY.

To the Editor of the Electrical Review:

We are apt to look at the world from our own point of view, and I am, therefore, in what I am about to say, confining my reminiscences to my own personal experiences.

In 1887 the Boston Edison Company had quite a discussion in its own ranks as to whether there was installed at that time an equivalent of either 6,700 incandescent lamps or 6,900. During the last ten days of 1901 over 8,000 lamps were added to its circuits. When the Head Place station, having a possible capacity of forty 50-kilowatt generators, was finished, a severe criticism was passed upon the management because it was thought it would never be possible to obtain sufficient business to use up the capacity of the station. We have recently ordered for the coming winter's load an additional capacity of 3,200 kilowatts, and have no reason to doubt that it will be necessary to duplicate this order for the next year, all of which means that the electric lighting business of to-day is growing at such a rate that it is hard to remember that fifteen years ago it did not exist. I have still a very vivid recollection of the night in July, 1883, when W. S. Andrews started up the first three-wire plant in Pennsylvania. It was more of a red-letter day than is the completion of a 25,000-kilowatt central station of the year 1901. Notwithstanding this great advance, it has all come about in such a short number of years that, as you say in your letter, the young men of those days are still the young men of to-day.

C. L. Edgar.

Boston, February 3.

HOW TWENTY YEARS HAS CHANGED OPTIMISM TO ACCOMPLISHMENT.

To the Editor of the Electrical Review:

I take pleasure in congratulating the Electrical Review, and its worthy editor, upon having reached its twentieth birthday.

From my point of view, the greatest strides in the electrical world within the last twenty years have been made in the direction of light and power. The development has been simply astounding. We have gone from the imponderable to thousands of tons weight—from light to that point where trains of great tonnage are moved by electricity—and in my opinion the field has hardly been touched.

When in the early nineties, in a paper read at a convention at Denver, I attempted to call the attention of railroad people to this phase and begged them to avail themselves of it, technical railroad journals very pleasantly charged me with a serious case of optimism. Looking backward, the editors to-day would probably not be angry at me if I should say, "I told you so."

I have selected what I consider the greatest development, but alongside of this there has been such progress in electrical lines and application in so many ways, each having a specific field, that it would take a long article to even treat of them by mere mention.

We all should feel well satisfied and thankful that our lines were cast in the electrical places, and that in our little way we have helped to do the future world a great deal of good, and to that end no journal has more consistently or more steadfastly held than the one managed by yourself. Wishing you many happy returns of the day, I am, yours truly,

Charles Selden.

Baltimore, January 31.

Reminiscences of an Old-Time Telegrapher.

By Henry A. Reed.

ON this, your twentieth birthday, you can boast of having witnessed and recorded for a score of years the wonderful development and achievements of the science for which you were named.

Your memory goes back to the time when the streets of our cities were fairly littered with poles and wires for both telephonic and telegraphic purposes, and also with those for the more dangerous currents for electric light and power.

Now as you ride through Manhattan or other of our principal cities in elegant cars, heated, lighted and propelled by electricity, which is conducted and applied by invisible agents, and consider that all the energy necessary for these various functions and also much of that used for lighting the streets and great buildings is being extracted from coal which is burned miles away, you and most thinking people say, not as did the first public telegraph message, "What hath God wrought?" but what hath the inspiration of God enabled man to accomplish?

If some "old-timer" should repeat the familiar saying, "This is not so wonderful as what they did when I was a boy," you would think him an old fossil. Yet he might be more than half right. You were born in an electric age, after telegraphic lines and cables compassed the earth and people had become quite familiar with the telephone another thing had taken place of equal importance. The commercial world had gone wild with the idea that there was money in anything which was electrical.

How different two score years earlier. Then, as now, New York was the first city of the land, but its streets were lighted by whale oil lamps. Its water was obtained from cisterns which were supplied from dirty roofs and street pumps, which were in dangerous proximity to various sources of contagion, and there were no sewers.

The trucking was done by single drays without springs, and the only public conveyances for the people were three or four lines of omnibusses, all of which started at South Ferry and each ran about three miles to various points on the northern limits of the city. The fare was one York shilling.

Faraday and Morse were both born in the year in which Washington was first inaugurated president of the United States. Daniell was then about one year old. Henry was born six years later.

The first recording telegraph, which was the result of the combined labors of these four great men, although for more than half the number of years that measure your life it was enduring its birth throes, did not become a publicly acknowledged child of science until 1843.

In that year, with difficulty, an appropriation of $30,000 for building an experimental line was obtained from Congress, it being then impossible to engage private capital.

Colonel Tom Benton, as he voted aye, said: "Give the crank the money to get rid of him." Hon. Cave Johnson, who two years later became Postmaster-General, suggested that part of the appropriation should be used for experiments in mesmerism, and the Hon. Sam Houston thought Millerism should be assisted with it.

The acquaintance of the common people at that time with electricity was well illustrated (if you will pardon a personal allusion) by a neighbor of my mother's who enquired of her what Henry was doing. Being sure that the enquirer had never heard of electricity, she replied, "He is sending messages by lightning," to which the reply was, "Ah! that must be a mistake, for nobody but God Almighty can control that."

Such was the field in which the first telegraph was being established in 1844. Its first public exhibition in New York was in the winter of 1844-45 when Ezra Cornell (the founder of Cornell University) and Mr. O. S. Wood (who is still living), having paid Professor Stillman $50 for an opinion that the amount of electricity for their experiments would not endanger the buildings, were allowed to run a wire over housetops from the corner of Chambers street and Broadway several blocks northward and to amuse the people for the purpose of getting subscriptions to a stock of $15,000 to build a line from Fort Lee to Philadelphia.

Even at that date they watered the stock and gave $200 scrip for $100 cash. By this inducement they got from New Yorkers about half the subscription and the owners of the patents made up the balance.

The first record I find of electricity earning money was on April 1, 1844. The only line then existing was the government line from Baltimore to Washington. As the government had no use for it, consent was obtained to charge for private messages, the Postmaster-General fixing the tariff at one cent for four characters.

A certain politician was willing to take the risk of being the first fool, but claimed to have only one cent in change. The Washington operator said to Baltimore for him, "4," which was an agreed signal for "what time is it." The reply came back, "one o'clock." This customer seems to have paid the first cent ever earned by this great industry. This was the only revenue for four days. On the fifth day twelve cents were earned.

Soon after, however, people began to smell money in it, and in 1845 lines were built from Philadelphia to New York, to Harrisburg, to Baltimore and Washington.

In 1846 the woods were full of people hunting poles and a surprisingly large mileage of lines was built.

Starting from Utica lines were built each way, and New York and Buffalo were connected in the fall of 1848. This was the first line working from New York, although messages had been previously sent from Fort Lee, South, the messages having been taken across the river in boats.

When Professor Morse first announced that he had invented a recording telegraph people thought him a crank, if not a lunatic. When he first demonstrated the truth of his claim beyond a possible doubt most people looked upon it as an inspiration, as though it had been handed down to him as were the tables of the law unto Moses.

Later, and still, men wonder that this great invention should have been perfected by an artist instead of by such scientists as Faraday and Henry, or others whose work was largely along the lines leading up to it.

May this not be explained by the fact that the scientist is engaged in developing, or rather discovering, and explaining certain principles, whereas the great artist must be trained in the science of combination? He studies to combine his colors and thoughts for certain effects.

The portrait must not only be true in outline, but must show character, the portraiture of which requires that a large

amount of brains be mixed with the colors. As Morse had to paint a landscape by combining the strength of the mountain crag with the beauty of the shaded brook and the sentiment of the lover's bower, so he was able as an inventor to make his alphabet from ideas suggested by semaphoric signals, to use the dynamic force of electricity which had recently been discovered by Faraday and developed by Henry, and the constant-current battery of Daniell, as well as the mechanical genius of Vail. By the combination of these he succeeded in perfecting the Morse telegraph, practically as it is now used for ordinary commercial purposes on nearly every land line in the world.

HENRY A. REED.

New York, February 8.

British Telegraphic Improvement.

Sir John Leng, M. P., has received the following reply from Lord Londonderry, the Postmaster-General, to his letter of the 17th ult., in which he comments upon the recent interruption of the telegraphic communication, and suggested "that a submarine cable should be laid along the east coast, say from Harwich to Aberdeen, from which branches could be taken to Hull, Newcastle, Leith, Dundee, and Aberdeen." Sir John Leng further added that both in first cost and in maintenance such a cable would be much cheaper than underground wires.

The following interesting communication is abstracted from an English contemporary:

In his reply, Lord Londonderry states that the underground line to the north which is now being laid will extend, in the first instance, to Birmingham, Liverpool, Manchester, Leeds, Newcastle, Glasgow, and Edinburgh, and will afford security against interruption of telegraphic communication not only to these important cities, but also to many intermediate towns, while it will give practical security to Sheffield and the towns on the east coast, and increase the stability of the telegraphic service generally.

"To carry out your plans with any approach to efficiency it would be necessary to lay one four-wire cable from a point near Harwich to a point near Hull, one four-wire cable from a point near Harwich to a point near Newcastle, three four-wire cables from a point near Harwich to a point near Leith, and one four-wire cable from a point near Harwich to a point near Dundee, and continue the same cable to a point near Aberdeen.

"These cables, together with the necessary connecting wires to the Central Telegraph Office and the post offices at Hull, Newcastle, Edinburgh, Dundee, and Aberdeen, would cost fifty per cent more than the underground line to the north which this department is laying down, and it would afford no security to Birmingham, Manchester, Liverpool, Leeds, or Glasgow.

"The underground line is now approaching Stafford, and will be extended as soon as possible to Warrington, whence there are underground wires already to Liverpool and Manchester, and the scheme will be so carried out as to fit in throughout with the underground system and be available for making good interrupted aerial wires at a great many points. The submarine cables, on the other hand, would be out of relation with the overground system, and could not be connected or fitted in from time to time at intermediate points.

"In paper-insulated cables, although they are below aerial lines in electrical efficiency, we have a means of providing wires which are less costly and more efficient than those insulated with gutta-percha. We now, therefore, feel that we may proceed with the underground line to the north as far as the financial exigencies of the state will allow. No satisfactory type of paper-insulated cable for submarine use has yet been produced. It is still necessary in submarine cables to use gutta-percha. Therefore, if we resorted to submarine cables we should lose the advantage in electrical efficiency which we have gained in our underground line by the adoption of paper-insulated wires.

"There are other respects in which the submarine cables would compare unfavorably with the underground line. They would be more costly to maintain, they would be often and for considerable periods interrupted; they would increase the difficulty and cost of maintaining the existing Anglo-Continental cables across which they would be laid, and they would require to be entirely renewed much sooner than the underground line.

"But the main objections are that they would cost more to construct, would be less efficient from an electrical point of view, and would afford less security to the telegraphic communications of the kingdom."

A stone which a workman was dressing exploded recently at the Cartnell quarries, Thorold. Several accidents of similar character have occurred there. The quarry is leased by the National Contracting Company, of New York, which had about fifty men employed taking out huge blocks to be used in the big power plant at Niagara Falls, N. Y. It is thought moisture had got into the blocks, which, freezing, caused them to burst with great force.

Portraits.

In this issue are presented a number of portraits of the men who have conducted great electrical operations and who fairly represent the "captains of industry" in this particular branch of industrial development. Among them are those who have carried the arts of electric lighting, the telephone, the telegraph, the electric railway and kindred branches to their present high point of industrial development in this country. The gentlemen whose portraits are shown are all living and are all representative men on the industrial side of their various departments of activity.

In its issue of January 12, 1901, the ELECTRICAL REVIEW presented about eighty portraits of the engineers and scientists who had up to that time been foremost in contributing to electrical advancement. The series of portraits here shown is, in a sense, complementary to that list and shows the men who have laid the foundation for an industrial development second to none which the country can show.

Projectile-Speed Indicator.

The Wolf air-shock indicator, as described in *Electricity* (London), is adapted for electrically recording the speed of a projectile between two given points possesses many points of advantage. The Wheatstone screen method which, up to the present, has been the almost universally accepted medium for projectile speed measurements, consists of a pair of wire screens, each wound with wire of a suitable "mesh," and connected in circuit with a chronograph; one of these screens is placed in a suitable position near the muzzle of the gun, while the other is placed at a convenient distance, such as 100 yards, and, like the first, immediately in the path of the projectile. The latter, when fired, cuts first one wire and then the other, the actual time of fracture being electrically registered on the corresponding chronograph. The method is ingenious, but possesses an attendant demerit in that it requires resetting after each discharge, and also for different sizes of projectiles. The Wolf air-shock indicator, on the other hand, sets itself automatically after each discharge, and is applicable for various projectiles ranging between fairly wide limits as regards size. It consists of a couple of diaphragms which normally close the chronograph circuit; they are, however, so adjusted as to be set in momentary vibration by the conical air wave which immediately precedes the passage of the projectile, thus interrupting the circuit and recording the time. As with the Wheatstone screen, one of these is placed near the muzzle of the gun and the other at a convenient distance.

ALTERNATING CURRENT MACHINERY FOR HIGH AND LOW FREQUENCIES—I.

BY B. A. BEHREND.

The most marked feature in the recent development of the art of heavy electrical engineering is the centralization of power. Gigantic stations have arisen in our large cities generating enormous quantities of electrical energy in a single power-house and distributing it either for railway purposes or for street and incandescent lighting.

We see the parallel of these agglomerations of power in the field of political economy and, in fact, any physiological organism presents us the same phenomenon. It is a great law of nature, this development and control of energy from a single centre.

Most of our great power stations use alternating-current machinery producing alternating currents of high potential, transmitting the energy in the form of alternating currents to motors, synchronous and non-synchronous, to rotary converters, and to transformers for lighting purposes. Alternating-current machinery has thus been developed along two lines which, although not differing essentially from one another, yet show such material distinctions that it will be of interest to consider them in this article.

Arc lighting and incandescent lighting are not feasible at low frequencies. Incandescent lighting is unbearable at twenty-five cycles per second and even at thirty-five cycles it is very disagreeable. The same may be said of the alternating-current arc. At forty cycles and above both the arc light and the incandescent light are pleasant and satisfactory to the eye. Induction and synchronous motors are inherently very well fitted for forty or fifty cycles, and it is, therefore, most natural that our first alternating-current systems were designed for frequencies of between forty and fifty. It is not saying too much that, until very recently, all large European central stations were designed for frequencies near forty. It is only owing to the influence of American practice that of late central stations, especially in England, have been equipped with twenty-five-cycle apparatus.

It might be expected, without entering into details, that a good deal could be said in favor of either system. At first sight it appears as if a frequency which is adaptable to motors as well as to lighting would naturally be preferable to one which does not permit of lighting without the use of transforming apparatus, such as rotary converters or motors driving series arc-light dynamos. But a more serious consideration of the technical advantages and drawbacks of both frequencies shows that either system has typical advantages and typical drawbacks.

Let us first turn our attention to the generating units for sixty cycles. Omitting, for the present, the steam turbine as a prime mover most of our large generators are driven by steam engines of slow speed. Engines of 1,000 horse-power or more are rarely run at speeds higher than 120 revolutions per minute. Large units of 4,000 or 5,000 horse-power generally run at about seventy-five revolutions per minute. As the number of poles is inversely proportional to the speed, it follows that these slow-speed generators must have a very large number of poles. A generator running at 120 revolutions per minute and producing sixty cycles must have sixty poles, while a generator running at seventy-five revolutions per minute must have ninety-six poles. As these poles have to be placed on the circumference of a wheel, it is obvious that very large diameters are required to find space for all the poles. Let us illustrate our points by actual designs. Fig. 1 shows a 600-kilowatt two-phase generator running at 120 revolutions per minute producing alternate currents at 2,400 volts and sixty cycles. The generator is one of two machines built by the Bullock Electric Manufacturing Company for the city of Nashville, Tenn. The load consists mainly of arc lights, hence the necessity of using sixty cycles. As the sixty poles require a large diameter anyway, the flywheel is used to support the poles. From Fig. 1 it may be seen that the armature is very narrow, while the diameter is large. The bore of the stationary armature is fifteen feet, the length of the pole, measured along the shaft, being seven inches.

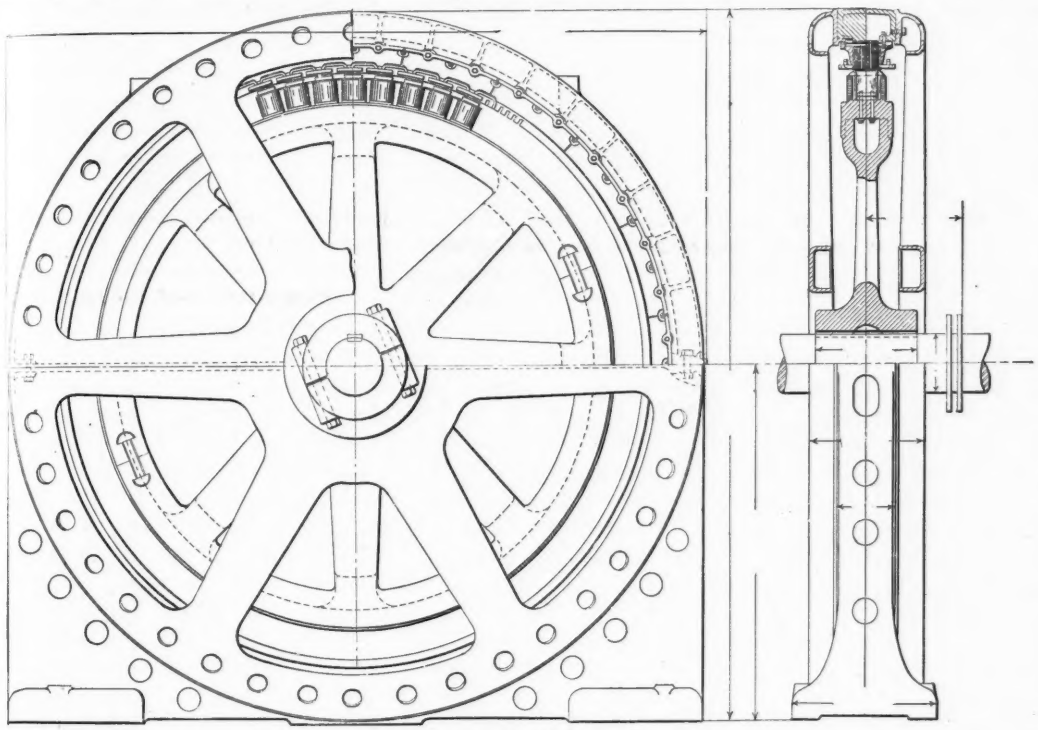


FIG. 1.—OUTLINE PLANS OF A 60-CYCLE GENERATOR.

Another illustration will serve to bring out more clearly the peculiar features of the sixty-cycle slow-speed generators. Fig. 2 shows a generator for 2,500 to 3,200 kilowatts operating at seventy-five revolutions per minute and producing 4,500 volts at sixty cycles. It is one of the units being built at present by the same company for the Cincinnati Gas and Electric Company. The revolving field consists of ninety-six poles which are dovetailed into the rim of the flywheel. Here again the great number of poles made it possible

to put the poles directly on the flywheel, thus avoiding a separate flywheel. While it is true that engine-type generators may be made somewhat smaller in diameter than flywheel-type generators, meaning, generally speaking, a slightly smaller cost of the machine proper, the advantages of the flywheel-type generator are certainly very striking from an engineering point of view. Instead of two revolving elements of approximately the same size placed closely side by side on the shaft of the engine, we have only one rotor which serves both as flywheel and as revolving field. If the load is subject to sudden changes the engine shaft and the arms of the two wheels may be subjected to immense strains, which are avoided in the flywheel-type of generator. Also the distance between the centres of the engine cylinders can be kept smaller and, therefore, the engine shaft may be made with a smaller diameter. The armature of the generator illustrated in Fig. 2 has a bore of thirty feet, the flywheel being somewhat larger than twenty-eight feet.

In order to make such narrow machines of large diameters mechanically stiff and rigid with a minimum of material, both for the 600-kilowatt and the 3,000-kilowatt units, a construction has been worked out which may be of interest. In Fig. 1 the yoke ring, in which the armature laminations are held, is made of a very light casting, rigidity being obtained by two cast-iron end-housings which are clearly shown in the figure. The feet in this generator are attached to the yoke and not to the end-housings, as in Fig. 2. The flywheel has the shape of a U, the poles being bolted to the rim, a construction which was originated by Mr. C. E. L. Brown.

The 3,000-kilowatt units are built up differently. The end-housings, made in sections and bolted together, are provided with feet. Between them are put the armature laminations, which are built up in twenty-four sections, each section being removable. The yoke is not a complete ring as in Fig. 1, but consists also of twenty-four sections, each section of the laminations being held in a cast-iron section of the same length. The sections are bolted to the end-housings.

In devising a construction which enables us to make, with a small amount of material, a stiff but narrow armature, lies the main difficulty of building slow-speed sixty-cycle alternators. It is, so to speak, a mechanical difficulty that is to be overcome rather than an electrical. The amount of active material on sixty-cycle generators of large diameter is small, and therefore it may be said that large diameters, as far as the material for the magnetic circuit is concerned, lead to economical designs. But, unless also economical mechanical constructions are chosen which unite rigidity and stiffness with a small weight, the economy obtained electrically will be more than balanced by the more expensive mechanical construction.

The efficiencies of these slow-speed, sixty-cycle generators are very high and the heating is extremely low. The former point, perhaps, is not so apparent as the latter. Of the generator illustrated in Fig. 1 the efficiency at full load is ninety-five per cent, while the generator illustrated in Fig. 2 has an efficiency of ninety-six and one-half per cent at a rating of 3,000 kilowatts.

As to heating, it may be remarked that, in the first place, the radiating surfaces are much larger than in machines of smaller diameter and greater length, and in the second place, the peripheral speed of these slow-speed, sixty-cycle generators is generally in the neighborhood of 6,000 feet per minute, and, therefore, excellent ventilation is obtained. As a matter of fact, the temperature rise above the surrounding air hardly ever exceeds thirty degrees centigrade, owing to the combined effect of the large radiating surfaces and the fan action of the revolving field.

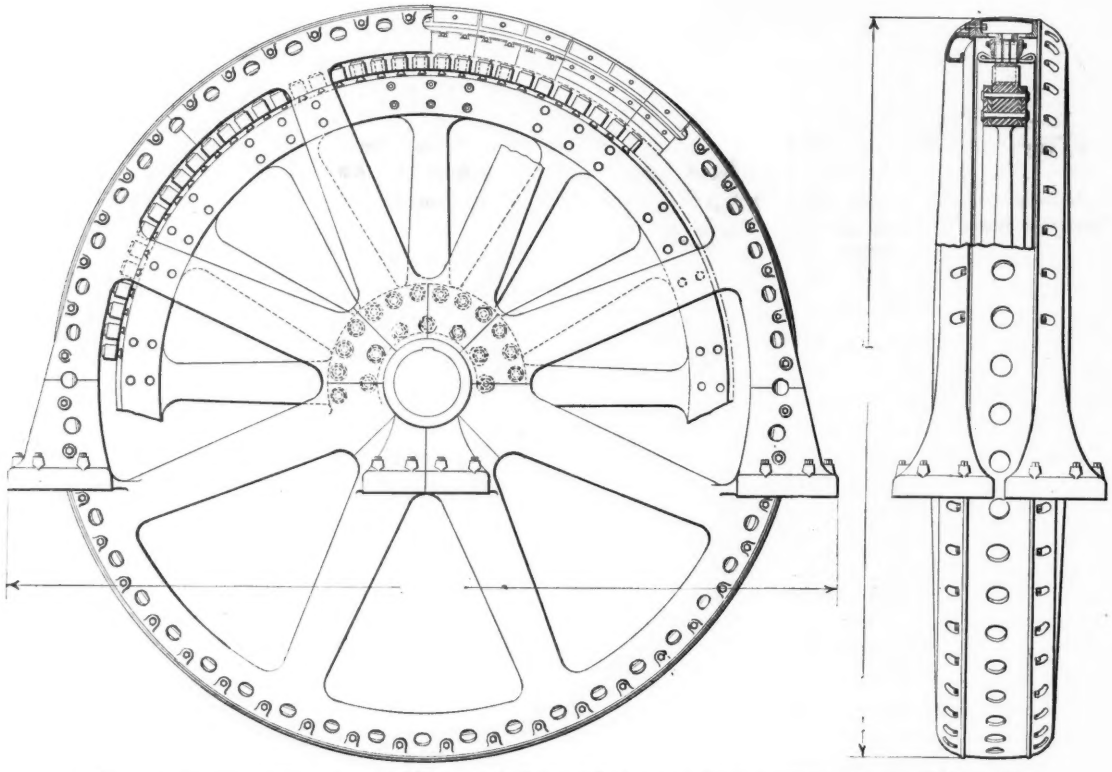


FIG. 2.—OUTLINE PLANS OF A 3,000-KW., 4,500-VOLT, 3-PHASE, 60-CYCLE ALTERNATOR FOR 75 R. P. M.

Electricity in Europe Twenty Years Ago and To-day.

(By Our Special Correspondent in Great Britain.)

OUTSIDE the field of telegraphy practically the entire development in electrical science and its applications in Great Britain and Europe generally has taken place during the past twenty years, and my endeavor is, not to give a history of that period—a rather too ambitious task in the pages of a weekly journal—but to give a few facts which will enable a comparison to be formed as to the extent of the use of electricity a score of years ago and its employment at the present time.

The period takes us back to the beginning of the year 1882, previous to the passing of the first electric lighting act in England. In the lighting industry these were the palmy days of the Jablochkoff electric candle, which had as competitors the Edison A and B incandescent lamp, the Swan incandescent lamp, and in a lesser degree Siemens & Crompton arcs and others. The price of Jablochkoff candles then stood at three shillings per thousand, and during 1881 some 2,000,000 were sold. As a result of the Paris exhibition of 1878 the Avenue de L'Opera in Paris was illuminated by this means for some years, as were also the Victoria Embankment in London, some large business houses in the same city, the Havre Docks and the Antwerp Railway Dock and Basin. The company operating the patents, in conjunction with those of Gramme and others, was the Société L'Éclairage Électrique with a capital of 6,550,000 francs.

In England the Brush Company, with a capital of £800,000, Messrs. Crompton & Company and Messrs. Siemens were executing most of the work then in hand. Thus we had the lighting of the city of London, being maintained by the Brush Company, Messrs. Siemens & Company, and a system known as the London system, this latter coming in when the Jablochkoff Company failed to fulfill its contract. At the same time what street lighting there was throughout the Continent generally was more or less of an experimental nature. The chief progress was being made in Great Britain, both in this and in private lighting, of which a great part was confined to mining work. The Edison station established in London for lighting Holborn contained the largest machines hitherto constructed, which were designed for 1,000 lights of sixteen candle-power, which were fitted two in each gas lamp-post. The "multiple arc" method of connection, an invention of Mr. Edison's, was used. Mr. Swan's incandescent lamps were just being introduced, and the British Museum and the Savoy Theatre were among the earliest installations.

Outside Great Britain, Edison companies were doing much work comparatively, and although the principal streets and squares in Berlin were electrically lit for the first time on April 15, 1882, by Siemens & Halske's differential arcs, after a committee had visited England and Paris, the National Bank in Berlin and other places, at Milan and Antwerp were equipped by the American concern, as was also the Strasburg Railway Terminus. In Madrid preliminary trials were being made with street lighting under the auspices of the Barcelona Electric Light Company. Siemens arcs were giving much satisfaction at the Milan Railway station and an extension of their use resulted, while probably owing to the large installation of electric lamps at the Paris Exhibition of 1881, *viz.*, 2,000 arcs, candles and incandescents, the Paris municipal authorities were moved to recommend the expenditure of 75,000 francs in order to demonstrate various methods of lighting their Council Hall, included among which were the Swan and Brush systems.

Reverting to the public lighting of Berlin, it is to be noted that this was the first municipal installation on the Continent to adopt the Siemens & Halske differential arc lighting system. At first there were thirty-six lamps in three circuits of twelve each, manipulated off Hefner-Alteneck dynamos driven by gas engines.

As will be seen from the foregoing, in practically every country in Europe coming events were casting their shadows before in these somewhat isolated instances of the use of the electric light. Previous to the beginning of 1882 almost all the capital was invested in a few select companies, but this year saw a great rush to incorporate, and before the year was out, England alone could point to some thirty companies with a total capital of over six million pounds; but it would be unkind to dwell upon the fact that a great proportion of these concerns were as quickly wound up.

In view of the enormous amount of theatre lighting now in vogue it is significant that theatrical managers were among the first to see the advantages to be obtained from the use of this illuminant, for on a small scale much was being done in this direction twenty years ago.

The inevitable bar to progress then was the want of anything like standardization in the various systems, but with a gradually increasing number of workers in the same field of operations, the process of evolution tended toward greater uniformity each year, and the present position of the lighting industry in the portion of the Eastern Hemisphere under review quite holds its own with the results of the efforts of its more democratic friends in the western states.

Great Britain probably has shown the greater advance, viewed from a certain standpoint, in spite of its somewhat characteristic conservatism. All the important cities in the kingdom are now supplied with electric light, either by a company or by its own municipal authorities. In London, the companies have held the field, there being no less than twenty in London and Greater London. Some 250 towns and cities have a public and private supply, in many cases from a number of stations, a figure likely to be considerably increased in no great length of time, owing to the introduction of the supply in "bulk" proposals now materializing, a means whereby the smaller communities are guaranteed a cheaper supply than they themselves could maintain. In addition, over 250 towns have stations actually being built or powers to build them. The capital expenditure of companies only is nearly £10,000,000 and a considerable larger sum has been invested by local bodies in electric supply.

In Germany there are some 800 electric supply works, indicating a capital expenditure of nearly £30,000,000, while the magnificent water-power stations at Rheinfelden, and the numerous other stations having large capacities, indicate sufficiently the contrast between the state of affairs twenty years ago and to-day. One noteworthy feature applicable to the "Fatherland" is the preponderance of municipally owned stations over those controlled by companies. In England, so far as lighting is concerned, matters are pretty equally distributed, as is the case in France, but in other countries munici-

palities do not always look with favor on embarking upon such enterprise. The aggregate capacity of the German stations is put at some 400,000 kilowatts. Italy claims a share in the credit for European progress if only by reason of the large water-power transmission plant at Parderno, while the distribution of electric power stations throughout France is in equal proportion to its rivals. Switzerland and Belgium, not having the geographical dimensions to accomplish anything of a startling character, nevertheless have not been left in the rear, especially the former, while Russia, by contrast as to territorial capacity, has made no abnormal show.

This, I think, disposes of the main points relating to electric lighting, and analyzing next the application of electricity to the purposes of locomotion we find ourselves on very barren soil a score of years ago. The state of this industry is fully demonstrated when it is stated that experiments were being made in Germany to prove that two tram-cars could be run upon the same line of metals without affecting each other's speed. These were made in the presence of Dr. Werner Siemens. Previously to this, at the Paris exhibition of 1881, an experimental car was in daily use and carried over 80,000 passengers. About this time, too, more ambitious trials were in progress on an ordinary steam railway between Paris and Gretz with what was an "intelligent anticipation" of the now little heard of Heilmann locomotive. A Gramme dynamo, driven by a Brotherhood engine, was placed in a locomotive engine. A second dynamo was at the back of the train, driven by a belt off the rear axle. This, besides supplying current to thirty-one Maxim incandescent lamps while the train was in motion, also charged a battery of ninety-six Tommasini cells, which were intended to take over the duties of lighting the train when the latter was at rest. These trials were upon the Eastern Railway Company's lines, but so far as the batteries were concerned they gave unsatisfactory results. Later on, Dr. Werner Siemens, with an improved apparatus, attained an average speed on the level of eleven miles an hour and overcame a grade of one in thirty at seven miles an hour. This experimental line ran from Charlottenburg to Spandauer Bock. The trolley was a tiny carriage with eight wheels, from which a couple of flexible cables supplied the energy to the car, and these experiments were said to have convinced Berlin electricians that the problem of adapting electricity to tramways had been solved.

The only other important demonstrations, at this period, to apply electricity to tramways was at the Crystal Palace, in London, where a system known as the Binko system of electric traction was exhibited. In this the current was transmitted from the power station to one of the track rails, from which it was conducted through the wheels to the motor and out through the opposite wheels, and thence to the other track rail. A line on a similar system, exploited by Messrs. Siemens & Halske, was also opened between Goth and Zandvoort, near Amsterdam. As a matter of fact, such a system was experimented with by Dr. Siemens in 1879. There were also some proposals being made by Mr. Edison at this time—*i. e.*, 1882—for constructing a couple of lines in Switzerland.

In comparison with the then condition of things greater progress has really been made with traction than lighting, as to all intents and purposes such a thing as an electric tramway or railway in the present-day acceptance of that term did not exist. It is true that the year 1883 saw a move in Ireland when the Portrush third-rail line, still running, was opened, followed soon afterward by the Birmingham accumulator line, but the difficulties encountered in connection with these projects, only serve to emphasize the advance. Much as Great Britain has been ridiculed in the matter of mileage comparison with the United States, she has certainly shown the way in Europe to the majority. In some of the European countries, such as Spain, Turkey, Portugal and even Russia, electric traction has received but scant attention, and as in the lighting industry the more important components of the Continent are preeminent, France chiefly so by reason of the mixed nature of its equipment to-day. Throughout France there are some 950 miles of electric tramways, etc., composed of trolley, conduit, accumulator, mixed accumulator and trolley, mixed trolley and conduit, and mixed trolley and surface contact systems. Of the total numbers of lines working, about two-thirds are by trolley. As recently as 1893 the total mileage was about twenty-five miles.

Germany has some 150 towns equipped with nearly 2,000 miles of lines. England, or rather Great Britain, has a similar mileage reckoned in single track distributed throughout some 100 towns. In some instances, however, such as Glasgow and Liverpool, the total of miles of track reaches 100. In Italy a deal of attention is being paid to the application of electrical energy to main steam lines, a fact unduly prominent by reason of the arbitration into the electrical equipment of the London underground steam line. In Amsterdam a municipal system of electric trams is in progress, and in Spain and Portugal one hears of greater acceleration than hitherto; the Barmen-Elberfeld single-rail line in Germany and Parliamentary sanction to a prototype between Manchester and Liverpool also serve to render more insignificant than ever the lines existing a score of years ago. Then, too, the progress made in Great Britain must be judged side by side with certain notorious legislative restrictive measures, which, although the opponents of municipal enterprise are apt to exaggerate their obstructive effects, have, nevertheless, retarded progress in a material way. Paris has now its "underground" contemporaneously with London, but London is the more fortunate, as it will shortly have two, if the publication of the arbitrators' decision in respect of the electrification of the steam one on the continuous-current system goes for anything. The development of mountain railways in the Alps of Switzerland and similar parts, although of small magnitude commercially, ranks high as an engineering feat.

But one finds one's self on much less speculative ground in 1882 in dealing with telegraphy and telephony, albeit, as stated at the commencement, the former was the more matured, even when we find 30,000,000 telegrams being despatched in Great Britain alone during the year, and this when the minimum per telegram was one shilling, as against sixpence now. Over 100,000 miles of wires existed in the British Isles, besides four cables between England and France, at Havre, Dieppe, Boulogne and Calais; and others connecting isolated places such as the Shetland Islands, etc. During 1882, also, severe gales wrought great havoc among these deep-sea lines which originated numerous complaints of the want of a departmental repairing ship, a state of affairs remedied soon afterward by the passing of the necessary bill by Parliament. Thirteen thousand instruments were in use and 326 towns were connected. In the head office in London there were 140 single needles, 200 Morse inkers, 170 Morse sounders, 65 Wheatstone automatics and 12 quadruplex. The German telegraph system was connected to 221 towns, and underground wires predominated. The German postal authorities are responsible for some of the earliest experiments in simultaneous telegraphy and telephony over the same line. Those were conducted by Messrs. E. Felten & Guilleaume on the government line be-

tween Elberfeld and Cologne, about thirty-two miles apart, and gave great success.

The following figures giving the mileage of country over which telegraph lines were laid in the leading countries of Europe in 1882 contrasted with those obtaining at present, serve to bring out in a strong light the great perfection of telegraphy even in those days as compared with the other departments of the electrical profession:

Country	1882.	1902
Great Britain	26,500	35,000
France	43,500	56,000
Germany	44,000	75,000
Russia	50,000	75,000
Italy	16,430	25,000
Switzerland	4,597	4,500
Belgium	3,000	4,000

The figures for 1902 are naturally approximate, but they may be taken as correct for the purpose. The mileage for some further countries at present is Denmark, 3,000; Holland, 3,500; Portugal, 5,500; Spain, 16,000; Turkey, 25,000. The following totals of telegrams despatched during 1881 are interesting. Great Britain, 30,000,000; France, 20,000,000; Germany, 16,000,000; Austria-Hungary, 9,000,000; Russia, 7,000,000; Italy, 6,000,000; Holland, 3,000,000; Sweden and Norway, 2,000,000. Present figures for the quantity of telegrams despatched graduate between 2,000,000 in Sweden and 100,000,000 in England. The land and submarine telegraphic communication is of the most complete character between all the countries of the Continent, and it is now possible, through the medium of the present-day international system, to effect connections between all the large cities of Europe without the slightest trouble. The further perfection of the class of communication will be the outcome of increasing business necessitating greater facilities for intercommunication.

Coming now to the last branch of the industry in which a critical comparison is at all possible, is telephony. Great Britain at once fills the eye by reason of the British Government at this belated period just commencing to give London, and London only, a government service. This industry in England has more than any other been a monopolistic one from its infancy. Originally in the hands of a number of companies the process of absorption by the present National Telephone Company soon left the latter in a commanding position, and from being in possession of 500 exchange lines and 200 private lines they can now point to some 1,000 exchanges, 3,000 call offices and nearly 200,500 stations. From this vast concern the Post Office takes a royalty which now amounts to over £150,000 annually. The trunk lines of Great Britain are in the hands of the government, whose revenue from these two sources has leaped from £9,000 in 1882 to over £400,000 at the present time.

The trend of events in other countries toward municipal ownership and consequently considerably lower rates puts Great Britain in the background of commercial telephonic development, the company's and Post Office subscriptions of £17 per annum being far and away in advance of anything charged elsewhere.

The use of the telephone in France in the early days is well pictured by the number of subscribers in the following towns: Paris, 2,200; Marseilles, 146; Lyons, 249; Bordeaux, 169; Havre, 129, and Lille, 79. At that time in Paris the Société Generale des Telegraphs owned a number of lines which were for the most part carried in the sewers, a metal return being employed. The now extensive utilization of telephonic communication completely overshadows these figures.

Even in this early stage of the telephonic development of the Continent the German postal authorities decided that the telephone business was an imperial monopoly. Connection was only possible then in Berlin, Frankfort-on-the-Main, Hamburg, Manheim, Mulhouse, Breslau and Cologne. In Berlin there were 900 miles of wire and 159 receiving offices; 560 miles of wire in Hamburg and 100 each in Frankfort, Breslau and Manheim, and the charge was five pfennigs (ten cents) for five minutes' conversation. Experiments were being made with an apparatus for transmitting between Hamburg and Berlin, and these experiments may be said to be the father of the elaborate system of long-distance telephony now existing. There are some 13,000 telephone offices in Germany, dealing with between 150,000 and 200,000 subscribers.

Again we find no material progress being made in Russia at about the year 1882, and in fact concessions have only just been granted for the five cities of St. Petersburg, Moscow, Odessa, Warsaw and Riga, two of which have been given to Swedish companies.

Among other countries well to the front Sweden claims a large mileage of wire, and a new system of direct telephone and telegraphic connection between Germany, Denmark, Norway and Sweden, commenced in 1898, has recently been completed. Sweden, indeed, in spite of its small natural dimensions, has had a leading share in this industry, as all the instruments used by the National company in Great Britain are "made in Sweden." Connection is now possible between Brussels and London *via* Paris, and an important overland route taking in many Swiss, German, and Italian cities is in contemplation. Berlin and Bordeaux, a distance of 1,200 miles, have been linked and, speaking from a superficial standpoint, telephonic communication needs little to be desired. As in all other branches the natural process of evolution is still at work, but the developments in the future can hardly, in the nature of human things, be of such a sensational character as in the past.

As stated at the commencement of the article, the facts given are only intended to serve as a guide toward an appreciation of the condition of the electrical engineering industry on the Continent of Europe at present, and to afford a realization of the magnitude of a twenty years' growth. It is obviously impossible to go into details respecting each individual country, and only the leading countries in a commercial sense have been picked out and thus dealt with. The advance noted in the particular instances may be taken as typical of the Continent as a whole. Only in the four departments referred to, viz., electric lighting, electric traction, telephony and telegraphy, is it at all possible to offer a truly critical comparison. But beyond these, the application of electricity has since found a multitude of outlets, if not undreamt of, certainly unheard of in 1882. In vaulting, so to speak, over a space of twenty years, it is necessary to record that details of methods of application have come into fashion only to disappear, but, peculiarly enough, in more than one instance, afterward reappearing and succeeding in getting recognized as the most economical practice. One sees an example of this in the efforts of Mr. Ferranti in the early days of London's electrical history, to introduce high-pressure generation and long-distance transmission and, at the distributing end, transforming down to the regulation voltage for lighting purposes; greatly condemned at the time of its inauguration in London, but now hailed universally as the *modus operandi* par excellence.

New applications might be mentioned *ad lib;* one standing prominently out nowadays, however, has lain dormant during some fifteen years and only comparatively recently has it been materialized. Experiments by the late J. B. Lindsay to determine the functions of space telegraphy without the use of wires were made across the River Tay in Scotland in 1882, and later on in the same year before the Southampton meeting of the British Associa-

tion, the then Mr. W. H. Preece recorded some experiments which he had made rendering Morse signals perfectly legible, but it is only during the last five years or so that the work of Marconi has resulted in the commercial use of this class of telegraphy.

Electrochemistry and the use of electricity for medical purposes were practical nonentities, but which now both form integral parts of the electrical universe. Electromobilism, a manufacturing industry now only retarded by reason of charging difficulties, electrical heating and cooking arrangements, and the thousand and one other utilizations of the electric current to be seen in all up-to-date cities of Europe all indicate that the electrical industry as a whole has, without doubt, made greater strides throughout Europe during the past twenty years than any other.

Falling back upon the commonplace phrase that "comparisons are odious" one feels the truth of this striking home with some force in attempting to make a distinction between the amount of money invested in 1882 and now. The two respective amounts are hardly sufficiently indicative of what has happened, since in 1882 practically the whole of the financial investment was in the hands of a few monopolistic trading concerns, and present-day figures, running as they do into tens of millions of pounds in all the chief branches, are out of all proportion to those obtaining twenty years ago. Further, in the traction department really no money at all was invested which was utilized to produce a practical commercial result, while the enormous spread of municipal trading has considerably narrowed the field of private enterprise, which latter, by the way in Great Britain, is strenuously opposing the slightest encroachment upon the preserves of what it looks upon as undoubtedly its own preserves.

The writer thinks that every reader of these notes will feel convinced that the work accomplished as shown herein is a work not to be ashamed of. To take the Continent as a continent our progress will stand the critical eyes of our neighbors, but no one denies that going into detail the advance has not been a uniform one throughout.

Electrical Development of Bangkok.

Consul-General Hamilton King writes a long letter from Bangkok, Siam, relative to trade conditions there. We quote the following paragraph:

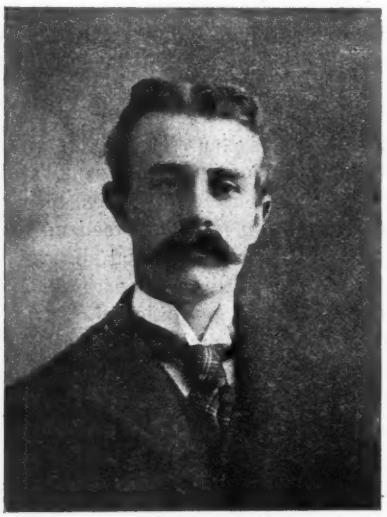
The electrical development of the city of Bangkok during the last ten years has been wonderful. The Siam Electricity Company, Limited, has a capital of £150,000, plus 200,000 ticals ($100,000); it has 17,000 lamps installed at sixteen candle-power; a tramway track of seven and one-half miles in operation, and a track of three and one-half miles under construction, which will be in operation before the end of this year; it has twenty six cars in use and fourteen under construction; it is advertising and supplying electric power for various industries throughout the city, and is now considering a line of automobiles to be run in connection with its tram line. Besides this company, there is being pushed a request for another concession on the other side of the river, and there are twenty-six private plants in the various mills, forts, dock companies, and the navy-yard of the city. The United States has almost the entire market in this line now, and, with interested and intelligent management, this trade should be greatly increased.

The American Electrical Works.

An excellent illustration of the way in which electrical industries in this country have grown in the last twenty years is furnished by the history of the American Electrical Works, now located at Phillipsdale, R. I., which was founded in 1870 by Mr. Eugene F. Phillips.

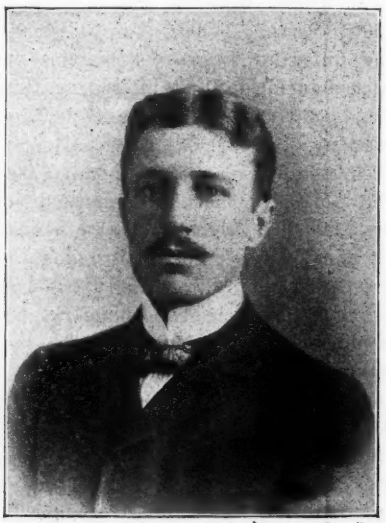
The accompanying illustration shows better than any description the rise in commercial importance not only of this firm but of the industry which it represents —the manufacture of bare and insulated copper wires and electric light, railway and telephone line material.

The business was begun in 1870 in a barn situated in the rear of Mr. Phillips's residence in Providence. After ten years had passed the business had increased to that point that a four-story building of fair size was necessary, this being considered in those days a large factory. By 1890 the factory buildings had grown to include nearly the entire city block in their neighborhood, while in 1893 the large buildings shown in the larger illustration were purchased and additions and changes made to fit them for business of wire manufacture. At the beginning of the enterprise the American Electrical Works consumed in raw material about thirty pounds of copper per day in the manufacture of wire; to-day the same works use upward of 100,000 pounds of this material every working day. The copper is received in ingots as it comes from the refineries and is put through rolling mills which reduces it to three-eighths-inch rods. These pass on then to the wire-drawing mills which further reduce it and extend it to form wire of all sizes, from the heavy gauges used for railway feeders to the hair-like



E. ROWLAND PHILLIPS.

EUGENE F. PHILLIPS.

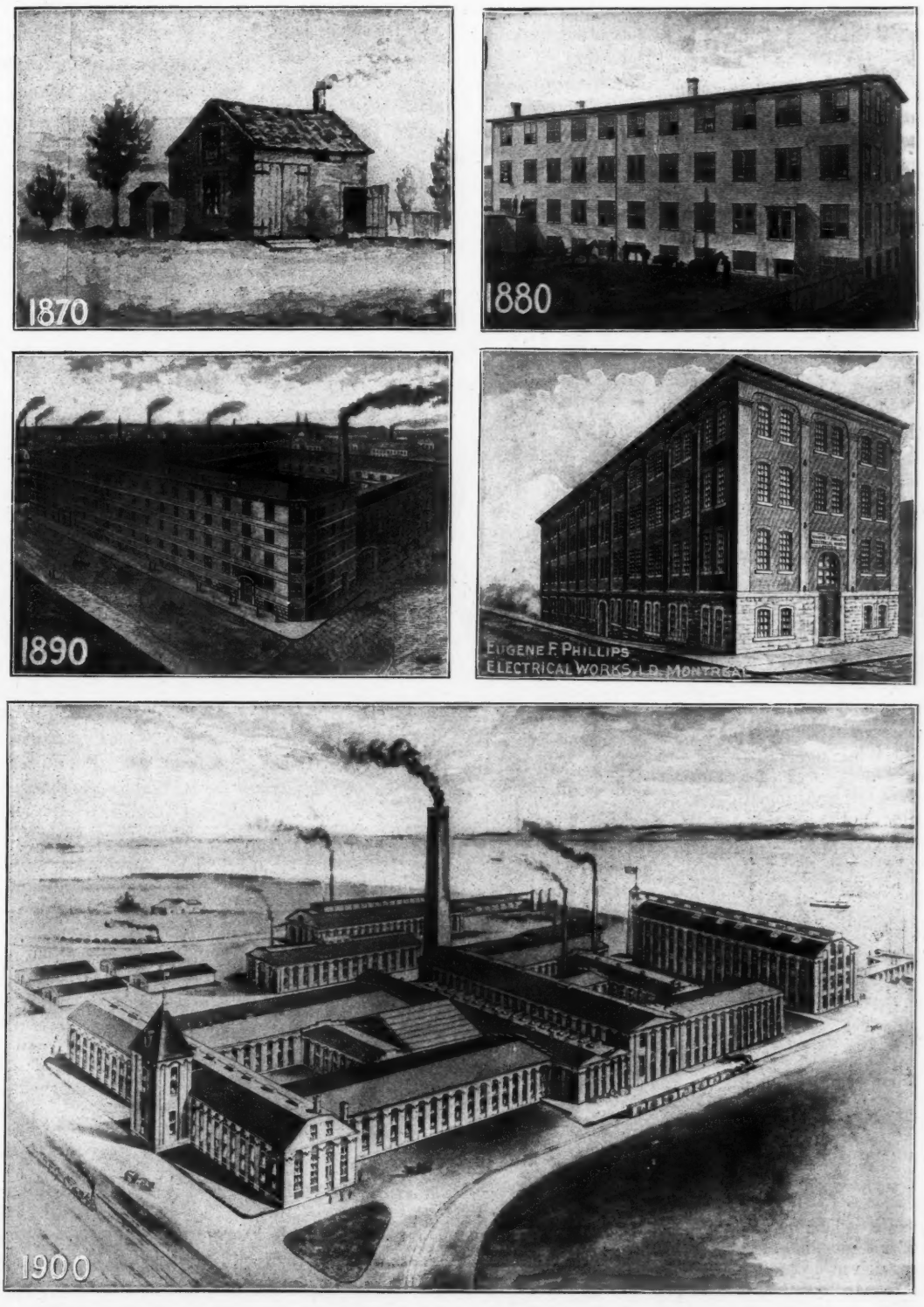


FRANKLIN. PHILLIPS.

wire used in telephone and scientific apparatus. The works absorb about 1,000 horse-power of steam-power and has its own electric light plant and power transmission. The company also maintains a large establishment in Canada, at Montreal, the building of which is illustrated in one of the engravings.

The growth of this large industry, which now employs more than 1,500 people, is due to the energy and business tact of Mr. Eugene F. Phillips, the general manager of the company. Mr. Phillips is widely and well known through the electric business as the organizer of the famous "clambakes," to which he has annually invited hundreds of his fellow-workers in the electrical field. These reunions have been occasions of more than ordinary pleasure and have literally been reunions, for to them people come from great distances with always the certainty of passing a delightful day and meeting old friends.

The other officers of the company are Messrs. Frank N. Phillips, president, and E. Rowland Phillips, vice-president, both of which gentlemen are sons of Mr. Eugene F. Phillips. Mr. Charles H. Wagenseil is treasurer and Mr. Charles R. Remington, Jr., secretary.



THE AMERICAN ELECTRICAL WORKS AT VARIOUS STAGES OF DEVELOPMENT.

The New York Electrical Society Meets in a Telephone Exchange.

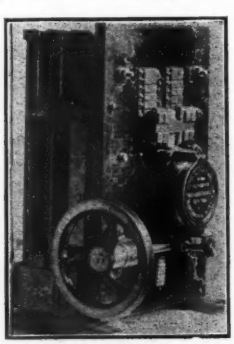
On Thursday evening, February 13, the New York Electrical Society was entertained by the New York Telephone Company at its Cortlandt street exchange. The society assembled in the large draughting room of the chief engineer's office and were welcomed by Mr. John J. Carty, chief engineer of the company, who made a short address in which he contrasted the condition and equipment of the exchange to-day with that of ten years ago, at which time the society had visited the same central office. Mr. Carty's comparisons were very interesting, and he entered with some detail into the reasons for the introduction of the common-battery system.

Mr. J. C. Renard, assistant chief engineer, then made a careful explanation of the common-battery system, using for the purpose a large diagram, and giving a great many interesting details of the engineering features of this magnificent telephone installation. At the conclusion of his remarks the visitors were escorted in parties, by members of the chief engineer's staff, through the exchange and shown its various appurtenances. The inspection was continued until a late hour.

An Automatic Motor-Starting Switch.

That there is a demand for a good and efficient type of automatic motor-starting apparatus is evident from the controversy that appears from time to time in the columns of the technical journals.

The illustration herewith shows an automatic motor-starting arrangement, devised under the Whittingham patents, and is one of many designs of this character manufactured by the Automatic Switch Company, New York city.



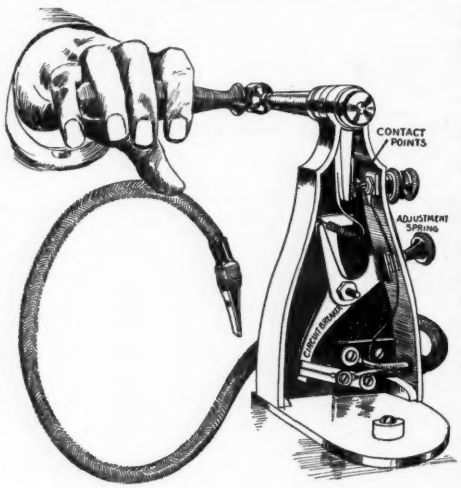
AUTOMATIC MOTOR-STARTING SWITCH.

By slowly turning on the current this switch, it is claimed, will obviate accident to the motor such as burning the armature, and will render impossible any damage to the machinery driven by the motor, at the same time safeguarding against accidents to those operating motor-driven apparatus.

A Novel Telegraph Sending Apparatus.

On another page of this issue is briefly described the introduction of a new apparatus for sending telegraphic messages. As will readily be seen this is a radical departure from the old-time key. The chief feature of usefulness in this new apparatus is the leverage medium and great varieties of position in which it may be manipulated. By having a soft contact point and adjustment spring to take up the tension a cleaner cut message is sent, thereby making the apparatus commercially useful on long-distance lines. This is known as the "Twentieth Century Sender," and in the short period of its existence has become immensely popular.

The illustration shows the working of this device, the movable front having been



"TWENTIETH CENTURY" TELEGRAPH SENDER.

taken off. The cord is plugged into the circuit and the key mounted on a frame which allows it to be moved at will in any direction.

The first evidence of change that an operator detects in using this new apparatus is a pain in the muscles of the upper arm, proving at once that the rigid and contracted movements of the old-time sender is being done away with, thus giving the only practical relief to men who have "lost their grip," but find it necessary to continue in service. This machine is being used extensively throughout the country, being rapidly introduced wherever it becomes known, and operators on all conditions of work are very enthusiastic over its inception.

This instrument, which was invented by Mr. Charles Shirley, manager of the operating department of the Postal Telegraph Company, in New York city, is manufactured by Foote, Pierson & Company, New York city.

PHILOSOPHY FROM THE HUB.

TO THE EDITOR OF THE ELECTRICAL REVIEW:

Electricity—

It was of the past, but we knew it not.

It is of the present, of which we know something.

It shall, in the future, ring up the curtain on an advance in mechanical industry that shall astonish the world.

I still have that barrel of second-hand sermons by the man who said electricity was in its infancy. FRANK RIDLON.

Boston, January 15.

The Viaduct Manufacturing Company.

The works of the Viaduct Manufacturing Company consist of some thirteen buildings, which include a power-house, machine building, wood-working machinery building, finishing department and two dry-houses; everything is on an elaborate scale. Every article is made in its entirety, and no expense or labor is spared to produce advantageous results.

This company's power is furnished by four water-wheels, and its product is sent out over the whole country and also to many foreign ports.

The Viaduct Manufacturing Company, Baltimore, Md., is the oldest concern, with one exception, making telephone and district messenger boxes in the world. It was established in 1871 as Davis & Watts, occupying a small building in the city of Baltimore, until in 1880 the property at Relay, on the Baltimore & Ohio Railroad, was purchased and the Viaduct Manufacturing Company was incorporated. It was at these works that the first Faure storage battery was made and experimented with in running an old car upon tracks laid in the company's own grounds. Finding this a success, a new and up-to-date street-car was ordered from J. G. Brill & Company, of Philadelphia, and was put in regular service on the streets of Baltimore. This was the first regular passenger car propelled by electricity made and used in this country.

This company has been advertising in the ELECTRICAL REVIEW, without omission, since this journal was first published. The present officers are: A. G. Davis, president; W. H. Winkelmann, treasurer; O. M. La Barrer, secretary; A. B. Davis, general manager.

Coal in China.

A coalfield of great extent, yielding fuel of a high quality, will shortly be in full operation within a few hours' steaming of Shanghai. The new fuel lies in the province of Anhui, near Ngankin, the capital on the Yangtse.

Electric Fans for 1902.

Illustrated Descriptions of Novel and Standard Electric Fans of Representative Manufacturers.

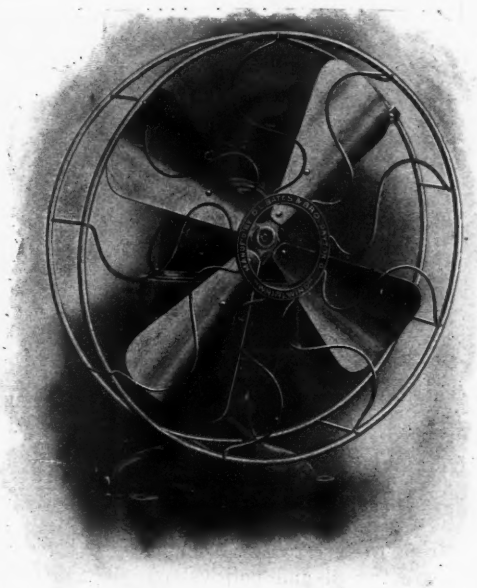
THE electric fan was a sort of haphazard invention. About 1886 Dr. S. S. Wheeler conceived the idea of applying a small propelling fan to one of the little motors which the C. & C. Electric Motor Company was then making for use with battery outfits. At that time and for two years later practically all small motors were run on constant current or arc lighting circuits. In 1888 the same company brought out 110-volt fans for use on incandescent lighting circuits.

Since that date the growth of the fan-motor industry has been remarkable. To-day there are a number of makers of the first class whose product has fairly become standardized and the little machines, notwithstanding they receive practically no attention, have made almost a new record for electrical machinery in operating year in and year out without trouble and with a minimum of expense for repairs and maintenance. The efficiency of fan motors has been greatly improved, until to-day the consumption of the desk fan motor, operating a six-bladed twelve-inch fan, is little if any greater than that of the standard sixteen-candle-power incandescent lamp.

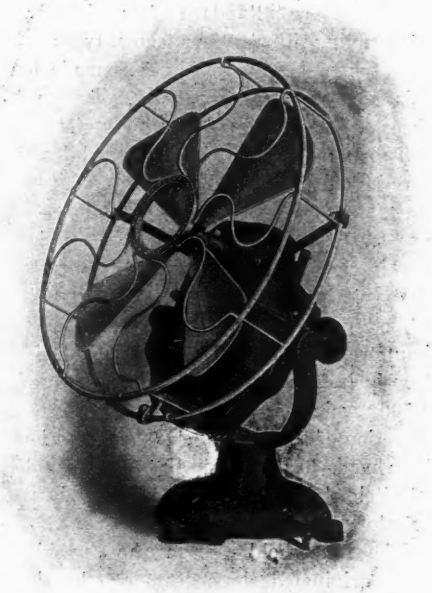
About the year 1892 the ceiling fan made its appearance and soon won a place in popular favor. On the following pages are shown typical illustrations of standard types of present-day electric fans. These machines are now made for both direct and alternating current at the usual voltages of commercial supply and have taken a place in popular estimation such that they are not likely ever to be displaced.

BATES ELECTRIC FANS.

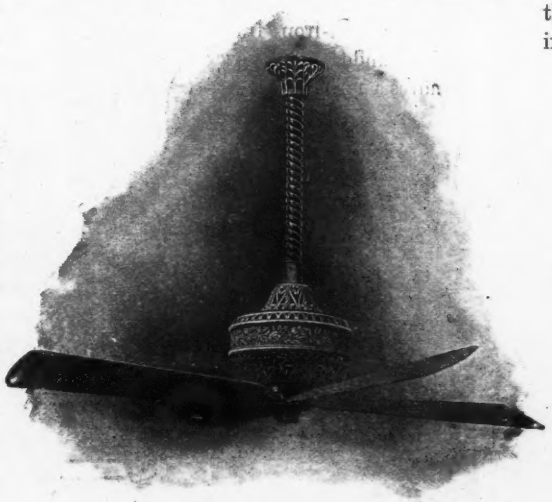
Messrs. D. L. Bates & Brother, of Dayton, Ohio, manufacture direct-current electric fans in all of the standard types. The desk and bracket type fans are of open bi-polar construction, which is excellently shown in the engravings. The ceiling and column fans are built with very large drum-type armatures in which the windings are made of form-wound coils slipped into slots and overlapping and interlocking with each other. The commutators are very compact and carefully assembled. The bearings of these fans are long, and the lubricating arrangements are such that they always run in oil, the oil supply being sufficient to last through an entire season. The ceiling types are made in a number of two and four-bladed styles, with an electric lighting fixture in the base.



BATES DESK FAN.



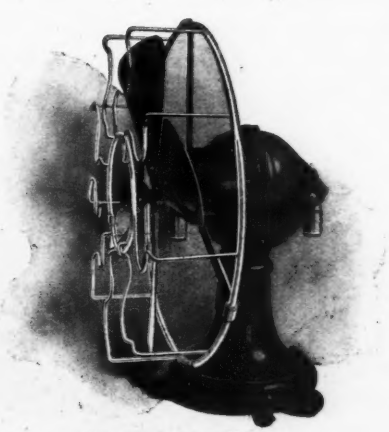
BATES SWIVEL AND TRUNNION FAN.



BATES CEILING FAN.

SPRAGUE FANS.

One type of the well-known electric fan apparatus manufactured by the Sprague Electric Company, New York, is here illustrated, this being a twelve-inch desk fan. Since the season of 1901 this and other types of fans made by this company have been improved, especially in regard to their electrical efficiency. The body of the fan is made of a soft casting, the two internal poles being energized by a single field coil. By means of a rheostat in the base the fans are enabled to run at three speeds, showing remarkable efficiency at each. For the season of 1902 new types of desk swivel and trunnion fans will also be brought out. These fans are made with



SPRAGUE DESK FAN.

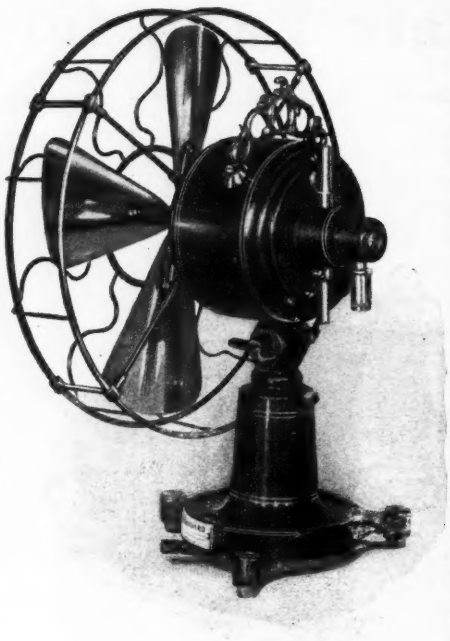
interchangeable parts and are carefully constructed to gauge and standard. They have been perfected through a manufacturing existence of a number of years and are already very well known on the American market.

"STANDARD" DIRECT-CURRENT FANS.

The Robbins & Myers Company, of Springfield, Ohio, manufactures a very complete line of direct-current fans known to the trade as "Standard" fans. The accompanying illustrations show types of the desk, wall and ceiling fans made by this concern and also of the fireproof rheostat employed in the former variety.

The desk and bracket fans exhibit a very high efficiency. The twelve-inch type consumes between twenty-five and forty-five watts and the sixteen-inch size between eighty-five and ninety-five watts, the variations being due to the inequality of voltage on various circuits. The maximum speeds of the twelve-inch and sixteen-inch fans are respectively 1,800 and 1,500 revolutions per minute. In the construction of the fans much experiment has been made to determine the correct angle of pitch giving the most efficient and satisfactory result.

The brush-holder is of the cartridge type, originated three years ago by this company, and consists of a clamp carrying a brass shell which feeds in a carbon pencil five-sixteenths by one and one-quarter inches in size. The brushes last under ordinary conditions several seasons of running. The commutator is built of hard-drawn bar copper, mica insulated, and is mounted on a steel sleeve. The leading wires to the commutator are firmly bound to an asbestos insulating ring on the rear collar, this preventing their being broken by vibration or rough handling. The bearings are made very substantially of hardened bearing metal. The construction of the machines are such that very perfect alignment is secured and can not easily be disturbed. The shaft is of machine steel, of unusually large dimensions, and the bearing surfaces as well as the commutator are turned and polished on centres. A self-oiling cup is provided for each bearing and with the heavy oil prepared especially for use with them last easily a whole season without renewal of the lubricant. The speed regulating switch and rheostat is shown in one of the illustrations. It is composed of contacts supported by a cast-iron frame upon its under side over which moves a spring-brass contact worked by a substantial iron handle. From this base rises a cast-iron tripod forming a triangular support or reel upon which is wound a guard ring of heavy wire. The insulation used is of heavy asbestos board and the wire so imbeds itself in this as to make it impossible to jar it out by any rough handling. All the switch parts are insulated by mica. The resistance wire is exposed on all sides to the free circulation of air and all parts of the rheostat are visible from the under side of the fan base. The fans are provided with swivel and trunnion movements.



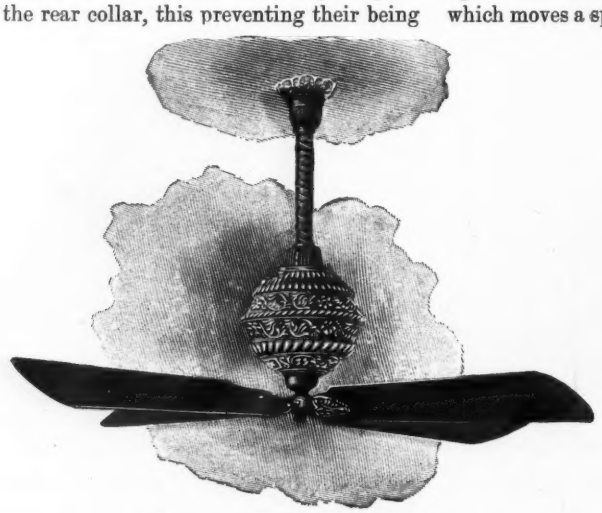
ROBBINS & MYERS DESK FAN.

The ceiling fans made by this company are of a number of types, the construction of the motor being easily understood by reference to the sectional illustration. It is hardly necessary to enter into details concerning this as the illustration so clearly shows the method of construction and of lubrication. The insulation hanger is made of leather, which prevents any vibration being transmitted to the room above and also minimizes the danger of breakage. These fans are made in a number of styles and finishes.

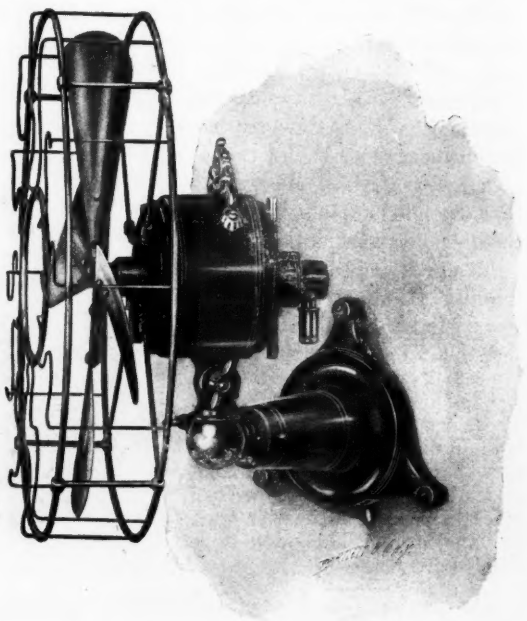
"PEERLESS" ELECTRIC FANS.

The Warren Electric and Specialty Company, of Warren, Ohio, has been for some years a manufacturer of desk and ceiling fan-motors which are known in the trade under the name of "Peerless." The manufacturers of this concern for the season of 1902 will maintain the distinctive qualities which have marked them in the past.

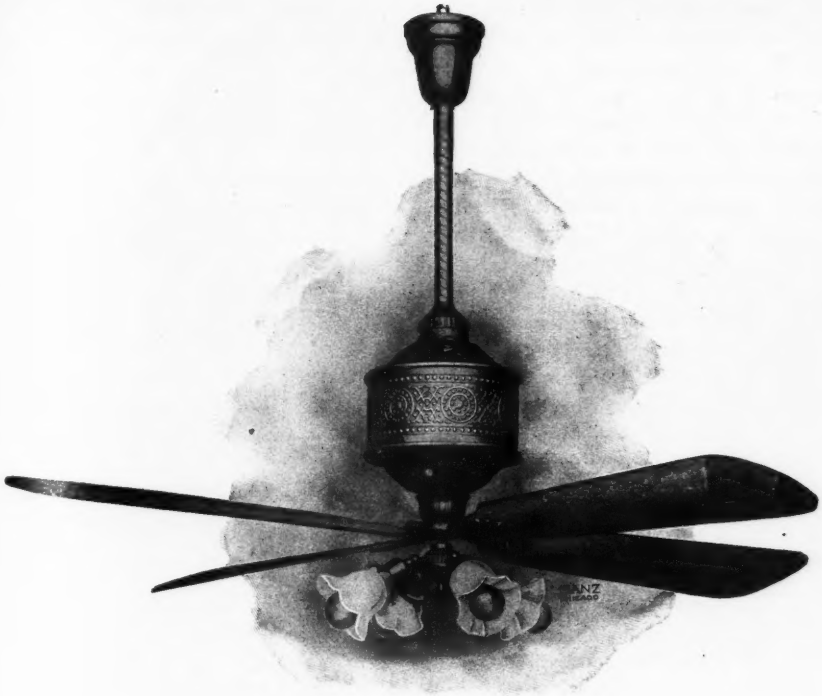
The ceiling fans are very elaborately finished and are constructed both in polished brass and in oxidized copper. The brush-holder arrangement is such that no tools are required for replacing the



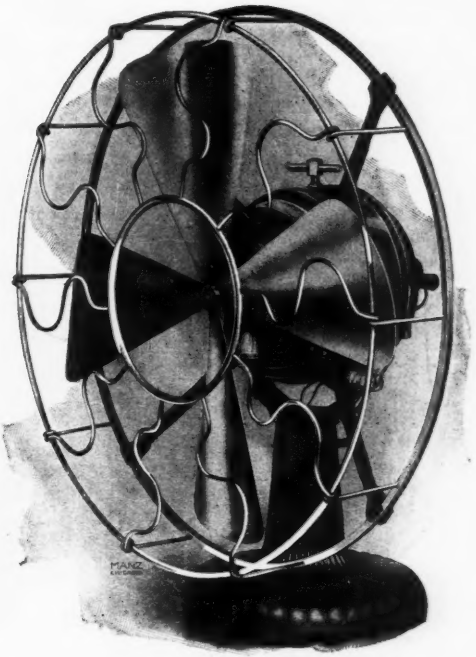
ROBBINS & MYERS CEILING FAN.



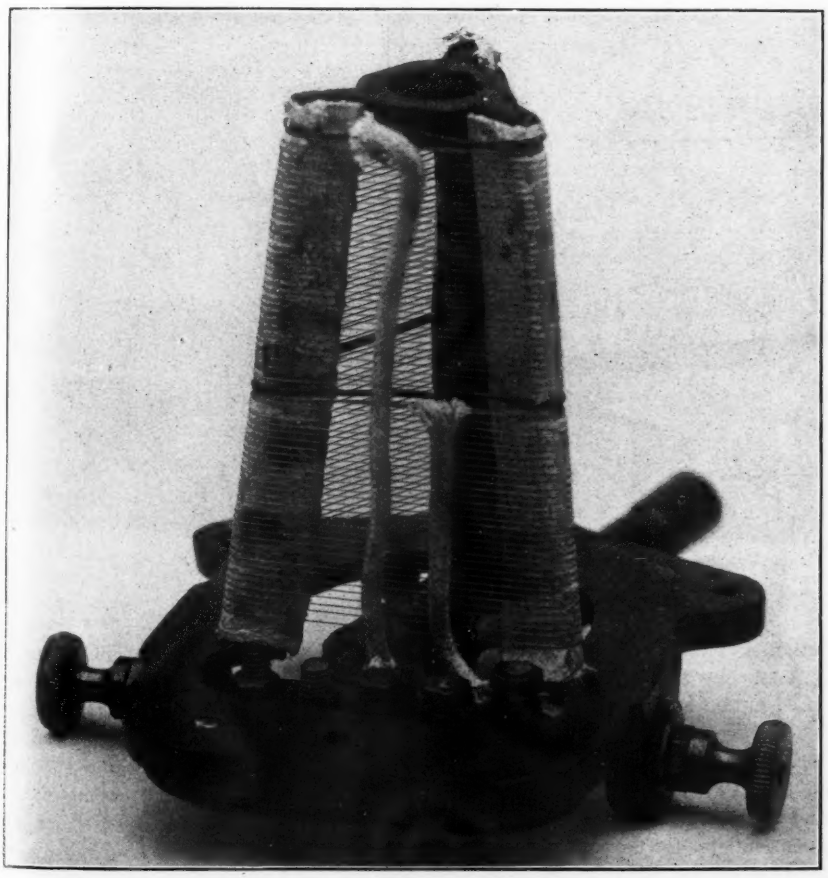
ROBBINS & MYERS BRACKET FAN.



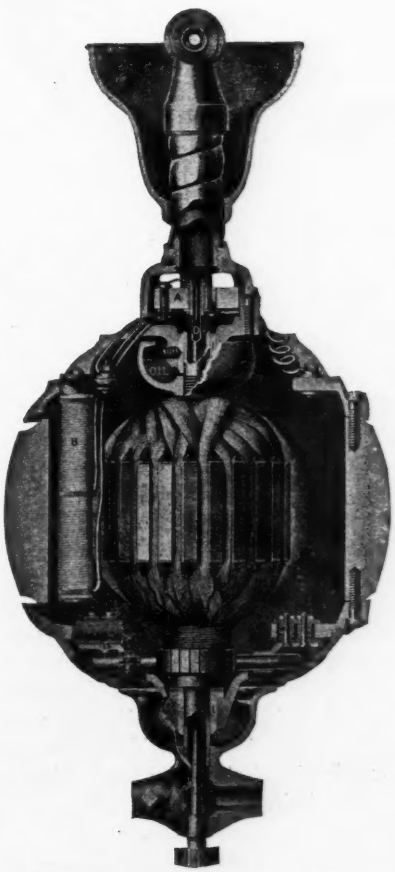
"Peerless" Electrolier Ceiling Fan.



"Peerless" Desk Fan.



Robbins & Myers Rheostat for Small Fans.



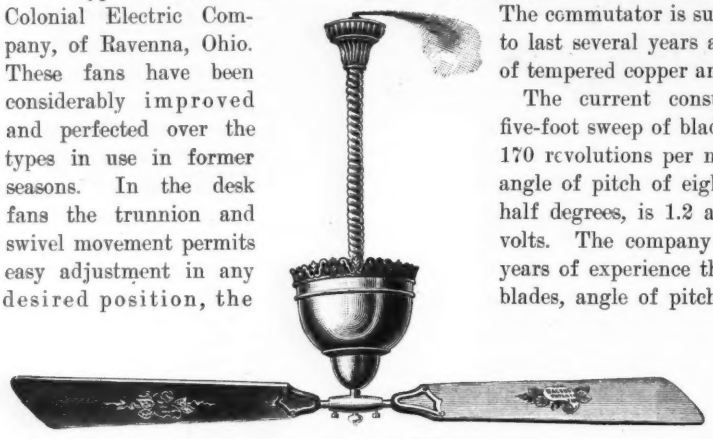
Cross-Section of Robbins & Myers Ceiling Fan Motor.

brushes. Great attention has been paid to insulation, which the makers claim to have been very highly perfected in this type. The oiling device is such that the bearings are constantly immersed in oil, the receptacle being large enough to hold an entire season's oil supply. The desk and bracket fans, of which the illustration show a type, are of the swivel and trun-

nion pattern, making them adjustable in any desired position. These machines are finished in black enamel, and great care has been used in both their mechanical and electrical construction. The working parts are easily accessible, and the brushes can be removed without the use of tools. With these fans, as with the ceiling type, great care has been taken with the insulation, the makers having aimed to produce a type of apparatus requiring no attention and able to run through a long season without any expense for repair or maintenance.

COLONIAL ELECTRIC FANS.

The accompanying illustrations show various types of electric fans made by the Colonial Electric Company, of Ravenna, Ohio. These fans have been considerably improved and perfected over the types in use in former seasons. In the desk fans the trunnion and swivel movement permits easy adjustment in any desired position, the whole being made instantly rigid by a turn of the thumb-screw. The guard-braces are made of malleable iron, which is claimed to have very superior qualities for this purpose. A simpler type of fan is also made, having three speeds and without the trunnion and swivel movement.



BACKUS CEILING FAN.

The ceiling fans of the same company's make here illustrated are very substantially made, great care having been taken in the design to make provisions against any part becoming loose or getting out of adjustment through wear. The oiling devices are a specially interesting feature, these being so constructed that one oiling lasts through a season. The ceiling fans are made for two speeds, controlled by a switch at the lower part, and are furnished in various finishes for any standard voltage from 100 to 500 volts. These fans are also made with electric light fixtures in the base if so desired.

BACKUS FANS.

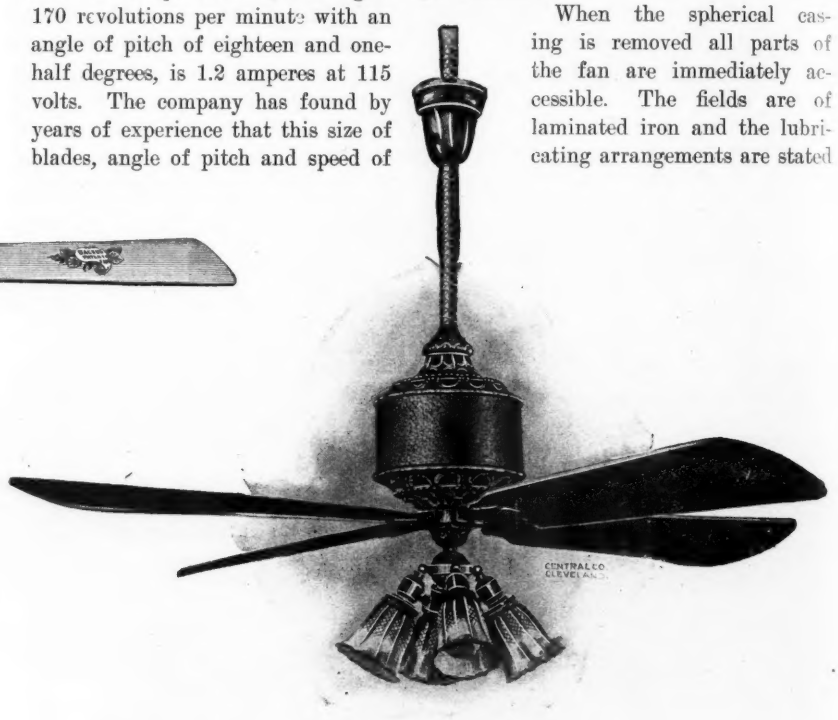
The Backus Water Motor Company, of Newark, N. J., manufactures ceiling fans of an interesting type here illustrated. In these fans only one long single bearing is employed running always in grease or oil, either of which may be used as a lubricant. The cup will hold enough to last two seasons. A fibre washer on top of the cup completely covers up the grease and keeps out dirt and dust. The general excellence of these lubricating arrangements can best be understood by reference to the accompanying sectional illustration showing the structure of this type of ceiling motor. The key-switch rod which passes through the hollow steel shaft is insulated for its entire length by means of a hard rubber tube. The switch is tested to stand 250 volts. All the field coils are interchangeable and are made to standard. The armature ring, which is built up of laminated steel discs, is machine wound resulting in a uniform, efficient and well-balanced construction. The commutator is sufficiently heavy to last several years and is built up of tempered copper and mica.

The current consumption, with five-foot sweep of blades, running at 170 revolutions per minute with an angle of pitch of eighteen and one-half degrees, is 1.2 amperes at 115 volts. The company has found by years of experience that this size of blades, angle of pitch and speed of revolution give the best effect in ventilation. A starting and two-speed switch is furnished so that by simply turning a button the fan can be driven at full speed or half speed or stopped. The motors are wound for 110, 115, 125, 170, 220, 230, 250 and 500-volt circuits. These fans are of course available for use as column fans. The company also manufactures a full line of desk fans.

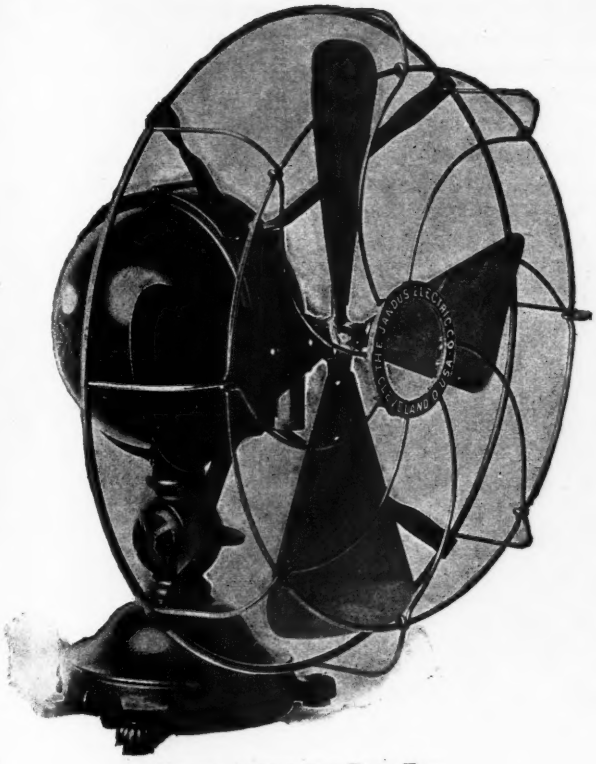
JANDUS ELECTRIC FANS.

The electric fans made by the Jandus Electric Company, Cleveland, Ohio, are of an entirely new design which the makers believe to combine many points of high excellence. The two bearings of the armature shaft are carried in a one-piece ring which maintains them in rigid relation to one another and does not allow the initial alignment to be disturbed no matter how carelessly the fans are handled. The standard design is a desk fan and a wall-bracket fan combined, as the illustrations show, the same apparatus being adaptable for either use. By the use of a thrust-bearing of an anti-friction design the armature may be mounted symmetrically with the pole faces, thus giving the machine a remarkably high electrical and mechanical efficiency. By adopting a slow-speed type the roaring noise due to fans running at high speeds is eliminated very completely. The fans are built for 110 and 220 volts and have three speeds, 800, 1,200 and 1,600 revolutions per minute.

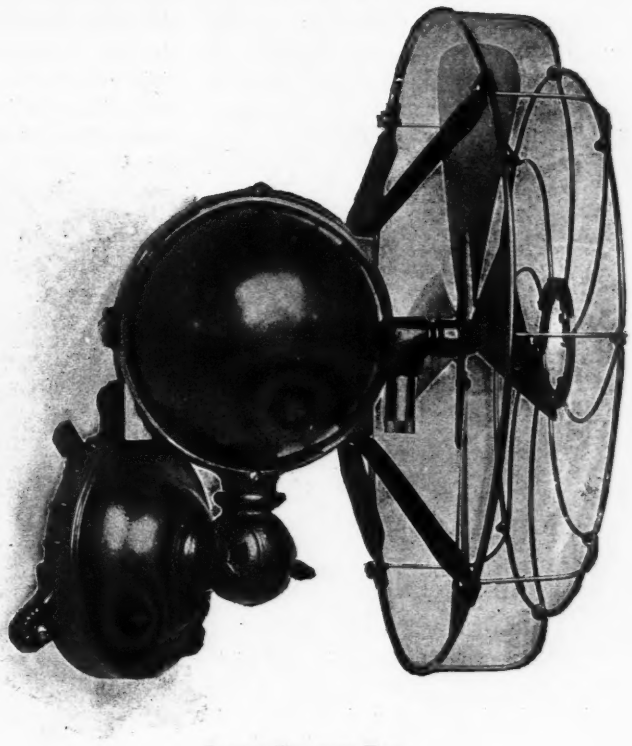
When the spherical casing is removed all parts of the fan are immediately accessible. The fields are of laminated iron and the lubricating arrangements are stated to be highly perfected. The armature coils are made of silk-covered wire and such parts as are exposed to wear, brush-holders and brushes for example, are massive and very carefully insulated from the motor frame. The rheostat is mounted on a porcelain base in the lower portion of the stand. Great care has been taken to avoid the throwing or spattering of oil by these machines and the design is such that the motors are completely enclosed, thus keeping out dust and avoiding troublesome wear.



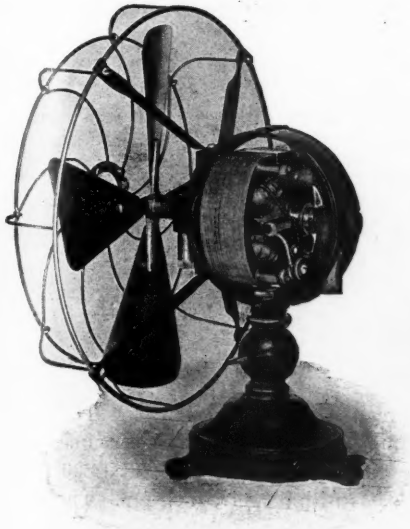
COLONIAL ELECTROLIER CEILING FAN.



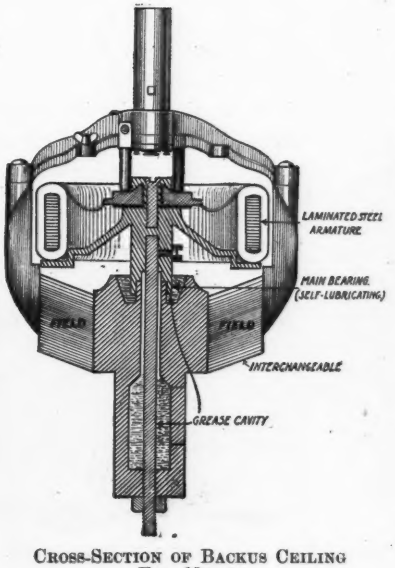
JANDUS ADJUSTABLE DESK FAN.



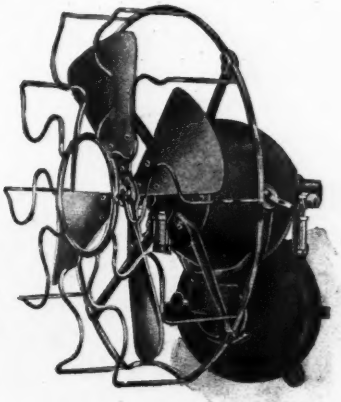
JANDUS BRACKET FAN.



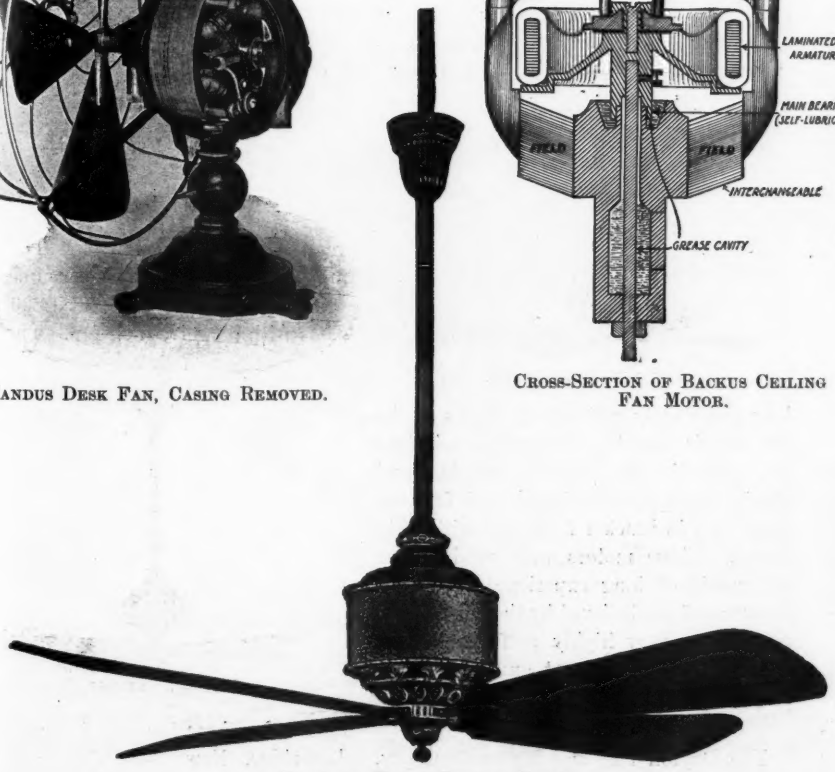
JANDUS DESK FAN, CASING REMOVED.



CROSS-SECTION OF BACKUS CEILING FAN MOTOR.



COLONIAL BRACKET FAN.

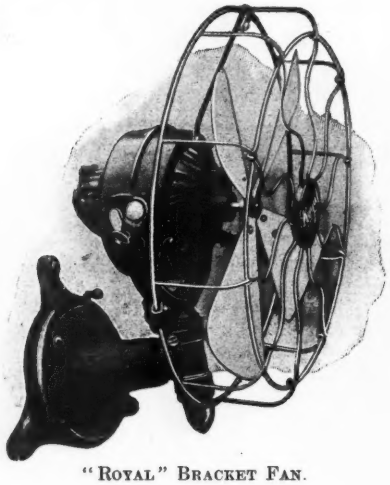


COLONIAL PLAIN CEILING FAN.

COLONIAL DESK FAN.

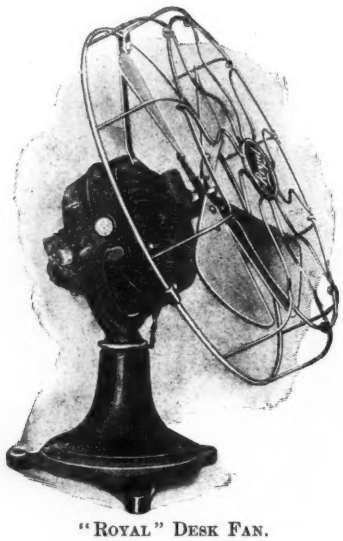
"ROYAL" DIRECT-CURRENT FAN MOTORS.

The name "Royal" has been given to the direct-current fan motors manufactured by Messrs. E. B. Latham & Company, New



"ROYAL" BRACKET FAN.

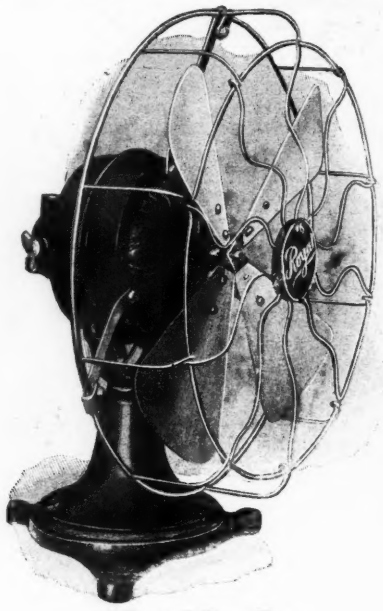
York city. The fans were designed to meet the demand for reliable and high-class apparatus and show great care in their mechanical construction. The field magnets are composed of laminated soft iron of the best quality, the armature being of the slotted-core laminated type. The commutator resembles that of a large motor and is made of forged copper bars



"ROYAL" DESK FAN.

with mica insulation throughout. The mechanism has been so designed as to make the apparatus dust and damp-proof, the working parts being completely enclosed by the outside frame. By removing one screw the brush-holders are readily exposed for adjustment if this is necessary.

As the illustrations clearly show, the swivel and trunnion movements are readily adjusted by thumb-screws while the fan is in operation. The fans themselves are made of heavy brass, highly polished and very carefully balanced to prevent vibration while running. The guard is constructed of heavy wire and is sufficiently rigid to be used as a handle in moving the fan. The bodies of the motors are enameled in black and highly polished.



"ROYAL" DESK FAN.

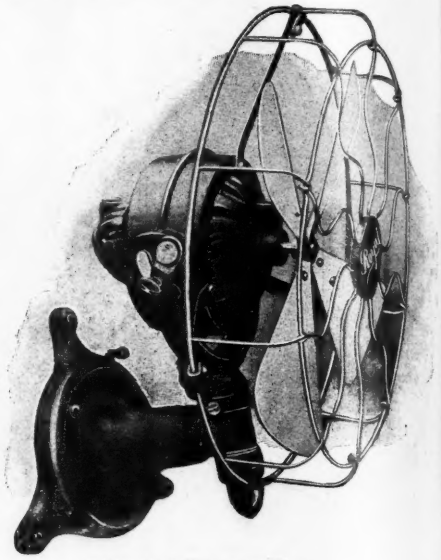
Each motor is furnished with a four-point regulator and switch, placed in the base, and governing the three running speeds of 950, 1,200 and 1,700 revolutions per minute in the twelve-inch sizes, and two speeds, 1,100 and 1,400 revolutions per minute in the sixteen-inch sizes. The power consumption of the smaller fans is thirty, thirty-five and forty-six watts at the three running speeds given, and of the

DAYTON CEILING FAN.

larger size sixty and seventy watts at the two speeds stated. The twelve-inch fans are made in the swivel, trunnion and bracket types and the sixteen-inch fans are built both in bracket form and with solid frame. These motors were produced as the result of long experience in manufacture and are believed by their makers to represent a very highly perfected design adapted for the severest and most long-continued use.

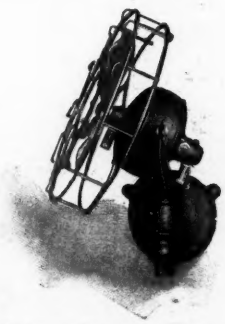
DAYTON ELECTRIC FANS.

The Dayton Fan and Motor Company, Dayton, Ohio, constructs a variety of types of electric fans for both ceiling, desk and bracket mountings. The fans here illustrated are much the same as the company has been making for the past ten years. The construction of the ceiling fan motors



"ROYAL" BRACKET FAN.

is very simple, these machines being made in two types, one having a Gramme armature and the other a drum-type armature. In both the matter of lubrication has been



DAYTON BRACKET FAN.

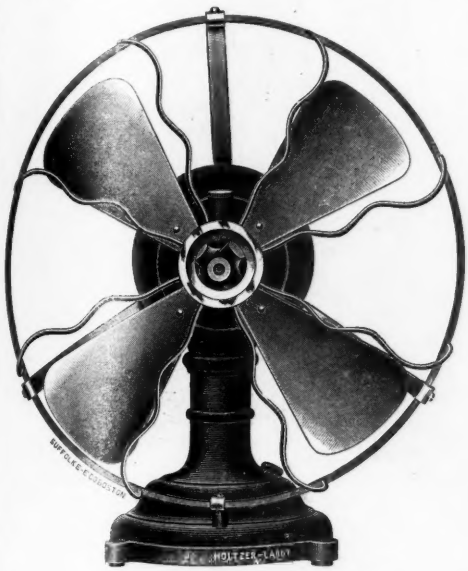
very carefully considered. The swivel and trunnion fan shown consumes forty-four watts when running at 1,800 revolutions with a twelve-inch fan. The selling

DAYTON CEILING FAN.

agents for these fans are Messrs. Lowe & Leveridge, New York city, and M. B. Austin & Company, Chicago.

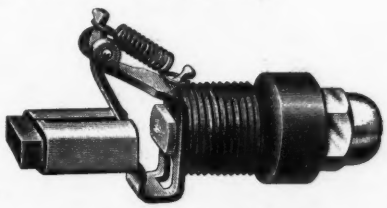
HOLTZER-CABOT ELECTRIC FANS.

The direct-current fan motors manufactured by the Holtzer-Cabot Electric Company, of Brookline, Mass., have been developed through a number of years of manufacturing experience and are made in types including a large variety of styles

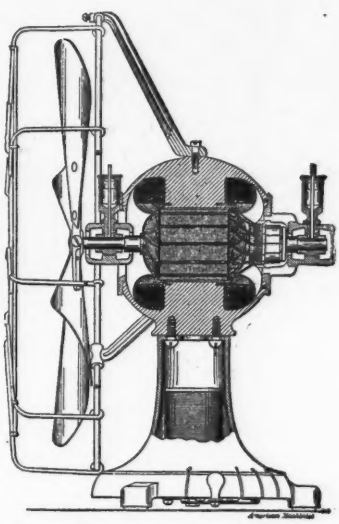


HOLTZER-CABOT DESK FAN.

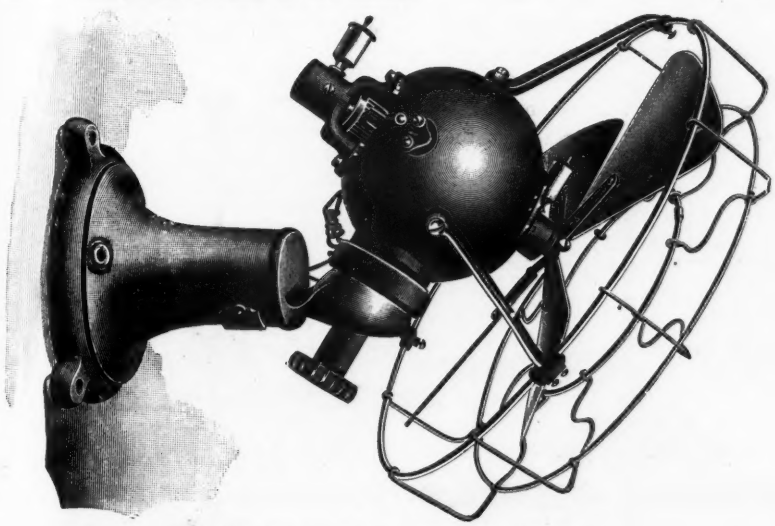
of these apparatus. The accompanying illustrations show a front view of the 1902 model twelve-inch desk fan and bracket fan and the improved brush-holder used in these machines, the illustration being the exact size of the brushholder. This latter device is adapted for using rectangular brushes which have the great advantage of not being able to turn in the holder, this being considered a fault in the ordinary pencil-shaped brushes. The body of the motor is built of soft steel carefully machined to size, the armature being of the laminated drum type. The windings, which are of silk-covered wire, are laid in slots. The field winding is reinforced by strips of micanite taped in the coil. A rheostat in the base of each fan gives four running speeds. These apparatus are characterized by great neatness of appearance and have been designed with careful reference to mechanical strength and durability in operation.



HOLTZER-CABOT BRUSH HOLDER.



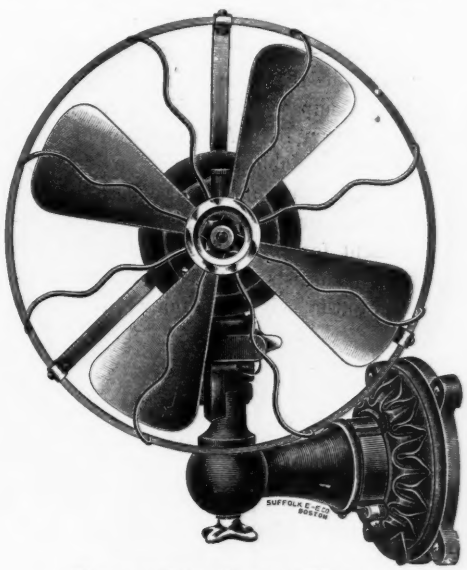
CROSS-SECTION OF ECK DESK FAN.



ECK DYNAMO AND MOTOR WORKS BRACKET FAN.

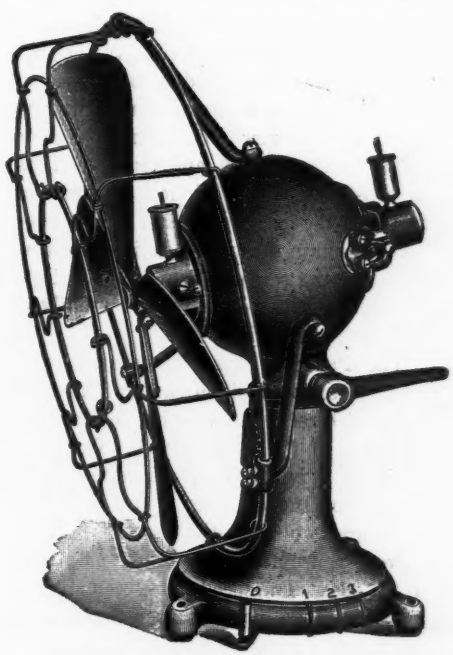
ECK FAN MOTORS.

The electric fans made by the Eck Dynamo and Motor Works, of Newark, N. J., of which Messrs. Goldmark & Wallace, of New York, are general sales agents, are known as "Hurricane" fans. They combine several features of novelty and interest. The illustrations show the fans adapted for attachment to a wall or for desk use, both types being adjustable. The ball-shaped body of the fan is made of cast iron, of good



HOLTZER-CABOT BRACKET FAN.

magnetic quality, and carries the internal poles upon which the magnetizing coils are wound. The armature is of the drum type, having a deeply slotted core, and runs in adjustable self-oiling bearings.



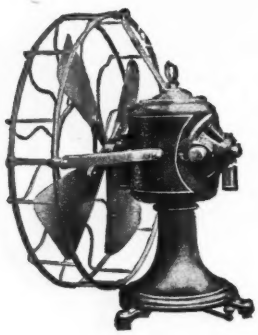
ECK DESK FAN.

The design of the motor is such as to make it virtually dust-proof and great mechanical solidity and strength mark all of its parts. The brush-holders are of a novel design, embodying features of great ex-

cellence and permitting the most ready and easy adjustment of the brushes. Such parts as should occasionally be inspected are left open to view and all the motors are carefully inspected and thoroughly adjusted before being sent out from the factory.

"PARAGON" FANS.

The well-known "Paragon" fans manufactured by the General Incandescent Arc Light Company, New York, have been changed very little for the season of 1902. The most notable change is an improved support for the guards on the desk, bracket and trunnion types, and an improved adjustment for the latter. The new guard support consists of three radial arms secured to the body of the fan while a fourth



"PARAGON" DESK FAN.

support is by the pedestal. This makes an arrangement of such rigidity that the whole fan may be picked up or carried by the guard without straining the latter in any way. A new adjustment has been added to the bracket and trunnion fans, so constructed that friction between the fork and the body of the fan is not relied upon to retain the latter position. Instead the clamping screw is so set that a slight tension upon it secures the fan readily in any desired position.

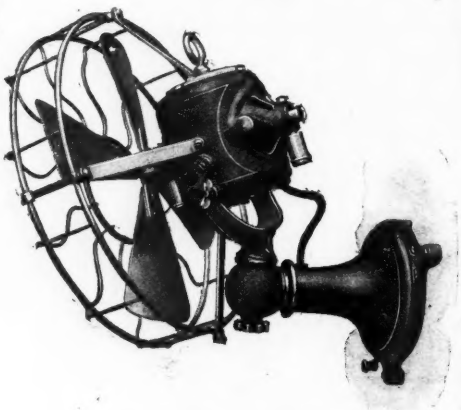
The "Paragon" fans are constructed with a one-piece magnetic circuit and are provided with rectangular carbon brushes and rheostats of the enamel type. The bearings are provided with retaining shields to prevent the creeping of oil upon the armature, while in the new models the current consumption is as low as always in the past. The speeds have been slightly increased, thus increasing the efficiency of the fan to a considerable degree.

TUERK FANS.

The Hunter Fan and Motor Company, Fulton, N. Y., manufacture the Tuerk fan for alternating current. This company is one of the pioneers in fan making. These fans have wide blades and great sweeps, suitable for all voltages and frequencies. They run at 175 revolutions per minute on forty, fifty and sixty-cycle circuits. Though little structural changes are made, the company brings the fans up to date each season. One illustration shows a Tuerk fan with electric light combination.

THE "COMFORT" OSCILLATING FANS.

The desk fans manufactured by the Shedd Electric and Manufacturing Company, New York, possess some features of novelty not found in other types. The



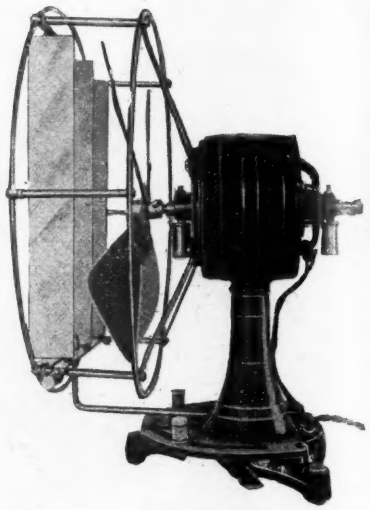
"PARAGON" BRACKET FAN.

most striking of these is the device, fully shown in the illustration, called an "oscillator."

The fan itself is of the open type of motor, this construction being adopted for the sake of good ventilation. The commutator is of the end-on pattern, thus enabling the brush tubes to be placed parallel with the fan shaft and securing what the makers claim to be important advantages. The leading wires from the

TUERK FAN, WITH ELECTRIC LIGHT FIXTURES.

armature to the commutator are thoroughly protected by a cup so that they can not be injured by dampness or broken in handling. The regulating resistance consists of a composition material made up in bar form which will stand practically any overloading to which it may be subjected. The oscillator is a de-



SHEDD OSCILLATING FAN.

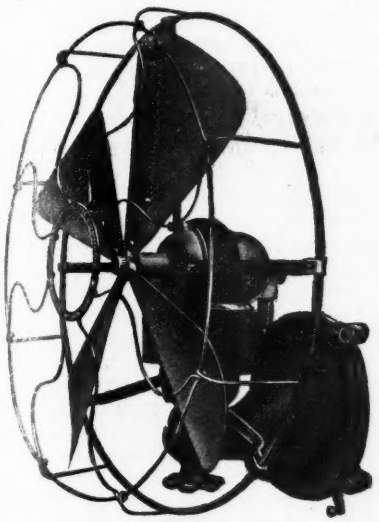
vice connected with the guard which stands in front of the fan. By means of a ball-bearing socket the motor and fan move with great freedom from side to side. The fan guard is provided with reversible blades which cause the fan, by the action of the draught of air produced by its motion, to move slowly from side to side, the limits of motion being controlled by a set-screw. When the fan reaches one limit the apparatus automatically reverses its action, thus causing the air delivered by the fan to be blown over a considerable area in-

TUERK CEILING FAN.

stead of being delivered in a "searchlight" shaft. This reduces the liability of producing colds and stiff necks which has been charged up against the fan motor, and at the same time renders the action of the fan as a ventilator gentler and more satisfactory.

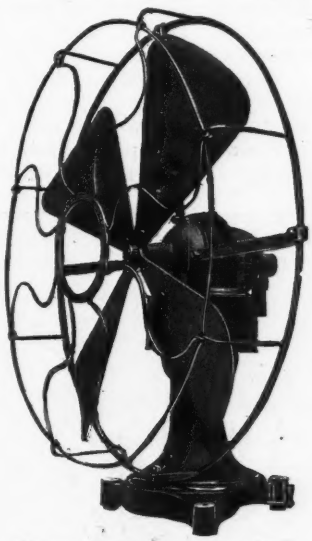
DIEHL FANS.

The Diehl Manufacturing Company, of Elizabethport, N. J., was one of the pioneers of the electrical fan business and the first company to produce types of fan adapted for suspension from a ceiling.

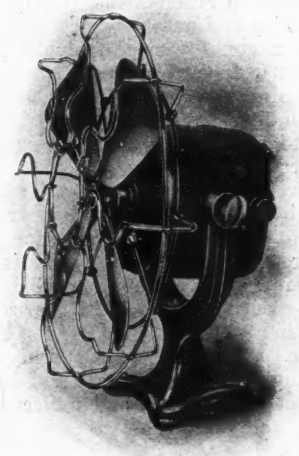


WESTERN ELECTRIC BRACKET FAN.

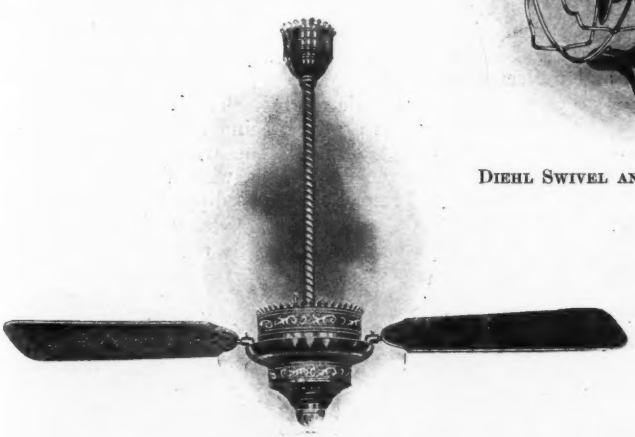
The accompanying illustrations indicate a few of the numerous types of electric fans at present manufactured by this concern. The ceiling fans are made with both armature and field cores laminated, and are provided with flat commutators situated below the armatures to prevent the accumulation of dirt. The oiling arrangements do not require replenishing during a season's run. The fans provided with electric light attachments are ingeniously arranged so that the lamp fixtures are mounted on a detachable bracket which may be removed or put on without interfering with the attachments of any wires. Of desk fans the company makes a large variety. The magnetic circuit of the fields is made of a single casting, while the armature core is built up of accurately slotted soft iron discs. The commutator is made of hard-drawn copper bars with mica insulation. In these motors the bearings are made of bronze, self-aligning and self-oiling. A unique form of brush-holders is included in the design of these machines, no wires or live parts being exposed. In the bracket types the fans are produced with a universal joint permitting them to be set in any position. The company also makes small swivel and trunnion fans adapted for telephone booths and other places where a very small fan is requisite.



WESTERN ELECTRIC DESK FAN.



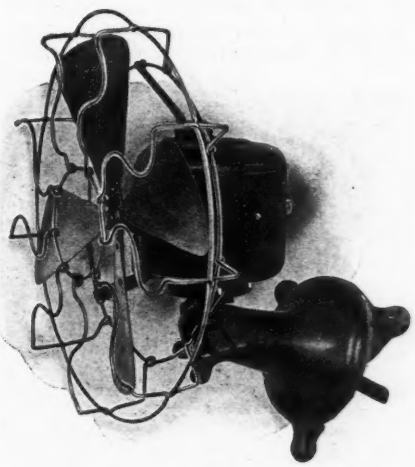
DIEHL SWIVEL AND TRUNNION FAN.



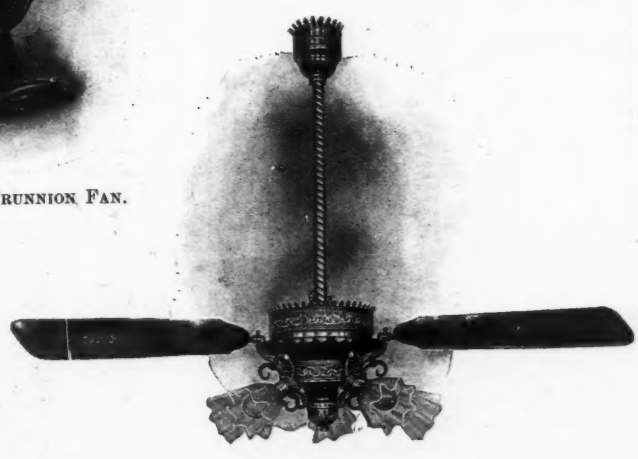
DIEHL TWO-BLADE CEILING FAN.

WESTERN ELECTRIC COMPANY'S FANS.

For many years the Western Electric Company, New York and Chicago, has been a well-known manufacturer of electric fans. The fans for 1902 retain most of the features of those of last season, the experience gained last year, however, having lead to certain improvement of elements of their design. The bearing brackets have been changed in both the desk and bracket motors so as to encase completely both of the journals and to furnish additional oil protection. This allows a wider range in the quality of oil used. The new rheostats are of the enamel type and are built of German silver wire embedded in white enamel and baked at a high temperature, making a practically indestructible rheostat. The contact lever has been modified and improved and a universal ball joint on the base of the bracket fan gives adjustment in any desired direction. The "Western" fan has been substituted for the "Arctic" fan manufactured in 1901, it being similar to the latter in all respects and this type may be furnished with a single-speed controlling



DIEHL BRACKET FAN.

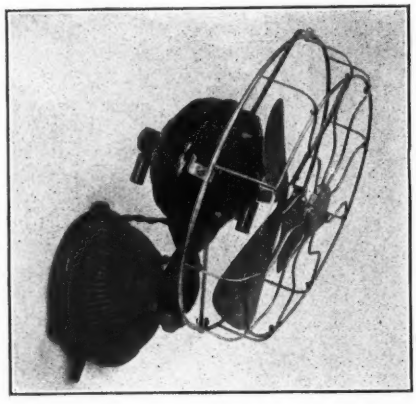


DIEHL ELECTROLIER CEILING FAN.

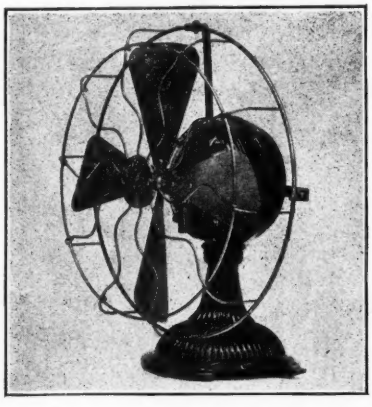
switch for use on 110, 220 or 500-volt circuits. The company manufactures fan motors for direct alternating and battery-current circuits.

GENERAL ELECTRIC FAN MOTORS.

The fan motors manufactured by the General Electric Company for the season of 1902 embody all of the characteristics of those of last year with only such slight modifications as experience has indicated as desirable. The standard sizes this year for alternating-current motors include



GENERAL ELECTRIC BRACKET FAN.



GENERAL ELECTRIC DESK FAN.

twelve-inch desk motors with swivel frames and with swivel and trunnion frames, twelve-inch wall bracket motors, sixteen-inch solid frame desk motors and sixteen-inch wall bracket motors. The direct-current motors are made in the

GENERAL ELECTRIC BANQUET FAN.

same sizes and styles excepting the twelve-inch desk motor which is made with the solid frame and with swivel and trunnion frame.

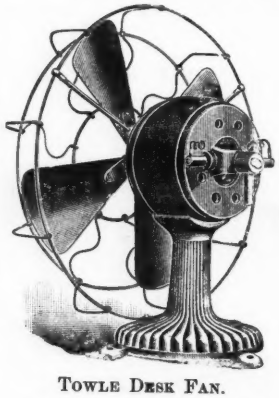
These motors are all fitted with variable speed switches. They are finished in black enamel, the fans, guards and trimmings being of polished brass. Attention is called to the fact that the guards are all fitted with two outer rings which, besides protecting the fan, increase the stiffness of the guard, a precaution made necessary by the rough handling to which motors are often subjected.

Beside the standard line of desk and wall-bracket fan motors, this company presents a special spring-supported bracket motor of ornamental design using a ten-inch fan. On account of its noiseless operation and attractive appearance this motor is desirable for private residences and sleeping apartments, particularly where the motor must be placed on walls or partitions where the vibration tends to make the operation of solidly-supported motors noisy and unsatisfactory.

These motors are made for both direct and alternating-current circuits.

The ceiling fan for 1902 is a four-blade fan with fifty-eight-inch sweep of blade furnished with black enamel or oxidized copper casing.

A novel and attractive fan is presented by the company for its radial fan motor. This fan is made for 115-volt direct-current circuits. It is intended for such places as dining and reading-rooms, where a gentle horizontal breeze in all directions is especially desirable. This device is twenty-four inches high, a six-blade fan eight inches in diameter being used and protected by



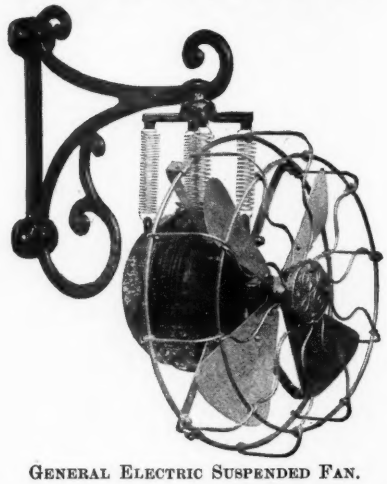
TOWLE DESK FAN.

a suitable guard. A three-speed switch is provided in the base of the motor which is connected to the circuit in the usual way by means of flexible cord. It is furnished with an artistic casing finished in streaked oxidized silver.

There is another line of fans which the General Electric Company lists with its fan motors this year. These are known as ventilating fan motors and consist of twelve or sixteen-inch fans mounted on a tripod and intended for use in openings in walls or partitions or in any place where it is desirable to remove not more than about 3,500 cubic feet of free air per minute. These are made for 115 volts and 230 volts direct current and 100 to 115 volts alternating current, 60 and 125 to 140 cycles.

TOWLE MANUFACTURING COMPANY'S FANS.

The accompanying illustrations show types of the electric fans made by the George C. Towle Manufacturing Company, of Lancaster, Pa. These fans embody only minor changes from the same company's types of fans for last season. The desk fan shown is made for one speed of running and consumes only twenty-two watts when running at 1,500 revolutions per minute with a twelve-inch fan. On all the desk fans cast phosphor-bronze bearings are used and automatic wick oilers. The guards are very rigidly fastened to the bodies of the motors, the lower part fitting



GENERAL ELECTRIC SUSPENDED FAN.

into a groove in the base making a very rigid support. All the desk fans are of a bi-polar type, the magnetic circuit being a single casting. This company's ceiling fans are now being constructed for 550-volt circuits. The armature is wound in seventy-two slots with silk-covered wire. The field coils are dipped in a special in-

TOWLE CEILING FAN.

sulating varnish and baked before being taped. The motor is enclosed in a polished brass cover. A column fan with a similar style of motor is also being constructed. This motor weighs only thirty pounds and is considered to be an unusually light type of its class.

CURRENT ELECTRICAL NEWS

COMMERCIAL NEWS

DOMESTIC AND EXPORT

COMMUNICATION WITH CONTRACTORS WANTED —A. F. Alibert, electrician of the Sociedad Minerayo Metalurgica, of Penarroya, Spain, is reported to be interested in a projected short tramway line in Penarroya, a place of some 2,000 inhabitants. He desires to be brought into communication with contractors who will undertake the construction of the system.

ELECTRIC POWER IN BROOKLYN NAVY YARD —The new electric power plant which has just been completed at the Brooklyn Navy Yard at a cost of $160,000 will be subjected to a final test by the contractors before it is turned over to the naval officials. The new plant will take the place of steam in running the machines in the different buildings in the yard.

ELECTRICITY IN INDIA—An East Indian house is reported to be interested in a project for the erection of an extensive water-power plant to be situated at Neral, about forty miles from Bombay. It is proposed to generate electricity for the purpose of supplying general power to various establishments in Bombay and immediate vicinity and to furnish current for the operation of the electric traction system which is about to supplant the existing horse tramways in that Indian city. American engineers are reported to be working on the scheme.

LONDON TRACTION PROFITS—The half-yearly meeting of the shareholders of the Metropolitan Underground Railway recently held heard the report which showed a profit of £200,000. It stated that arrangements were progressing for the installation of electricity and the equipment of the District and Metropolitan roads with a continuous circuit. The chairman of the Metropolitan had proposed a joint power-house, but the District company had decided to erect an enormous one itself. The Metropolitan company would erect a power-house at Kingsbury-Neasden within a year and a half.

ALASKA TELEGRAPH LINES—Permanent telegraphic communication between Valdes and Eagle City is to be established by next July. Captain Burnell, who left Valdes early last month to complete the line, said that he estimated that the remaining distance would be strung with wires within six months. Twelve men of the United States Signal Corps from Vancouver barracks have been sent north to aid in the work. About 100 horses and 250 tons of baggage will be sent with them. Wires have already been strung about twenty-five miles beyond Copper Centre.

WIRELESS TELEGRAPH STATION — Robert Appleton, Jr., representing the American Wireless Telegraph and Telephone Company, of Philadelphia, is investigating the feasibility of establishing a wireless telegraph station at some point along the south side of the island at East Rockaway, L. I. Among the sites which he has under consideration is the high ground on the land of Oliver Davison, twenty feet or more above the level of the ocean and the surrounding country, and, it is said, well adapted for a wireless telegraph station. If the site is purchased, a structure costing $80,000 will be built. It will be, probably, at least 100 feet high, and will be far above all surrounding obstructions, either on the mainland or the beaches.

A LONG TROLLEY LINE FOR GEORGIA—The Wadley & Mount Vernon Railroad has made application to obtain permission from the Secretary of State to construct a new line about 200 miles in length to run from Rixeville to Valdosta. The Wadley & Mount Vernon has done a considerable business for several years, and if put through to Valdosta from its present terminal will open up considerable new territory. The proposed extension will go through the counties of Emanuel, Montgomery, Laurens, Dodge, Telfair, Wilcox, Coffee, Irwin, Berrien, Clinch and Lowndes. The application states that the work is to begin at once.

AMERICAN TROLLEY FOR RUSSIA—It is stated that the Russian Government has just made an important concession to a syndicate composed entirely of Americans. It has for its object the electrification of the tram lines in St. Petersburg, Moscow and several smaller cities. The value of the concession is about $200,000,000, and the syndicate agreed to rebuild 315 miles of railway in addition to constructing new lines of railway in territory designated by the government. Mr. Murray Verner, who has been conducting the negotiations, and Mr. H. Sellers McKee, one of the largest stockholders, own valuable lines in Pittsburgh, Indianapolis and several western cities. The work will begin early in the spring, the overhead trolley system probably being installed, and a large force of American engineers will go to St. Petersburg.

MEXICAN RAILWAY—The Mexican Eastern Railway Company has been incorporated under the laws of Delaware for the purpose of constructing an electric and steam railway between Merida, the capital of Yucatan, the Coatzacoalcos, the Gulf of Mexico terminus of the National Tehuantepec Railway, which is now being constructed principally with American material by the British contracting firm of S. Pearson & Son, Limited, whose president, Sir Weetman D. Pearson, it will be recalled, left New York recently for the Mexican capital. The new concern also proposes to acquire telegraph, telephone and express privileges in that part of the world. The incorporators of the company include the names of John Phelps, of Baltimore, Md.; Sidney A. Witherbee, of Detroit, Mich.; Josiah Quincy, of Boston, Mass.; Sylvester T. Everett, of Cleveland, Ohio; Leander McBride, of the same city, and John Scott, of New York. The capital of the company is $5,000,000.

ELECTRIC LIGHTING

BELVIDERE, ILL.—The incorporators of the Sycamore, De Kalb & Northern Road have secured a right of way.

MOUNT VERNON, OHIO—A reorganization of the Mount Vernon Electric Light Company has been held and a new board of directors elected.

ALLENTOWN, PA.—A new lighting company, to be known as the Halcyon Electric Light and Power Company, will soon petition for a franchise.

SAN ANTONIO, TEX.—The present light and power plant of the San Antonio Gas and Electric Company will soon begin extensive improvements.

PHILADELPHIA, PA.—The annual meeting of the stockholders of the Electric Company of America will be held in Camden, N. J., on April 22, 1902.

MINNEAPOLIS, MINN.—An elaborate contract for electrical material for the new Chamber of Commerce has been let to Charles L. Pillsbury.

SYRACUSE, N. Y.—A directors' meeting of the Electric Light Company has decided to spend several hundred thousand dollars for extension and improvements.

GRAND RAPIDS, MICH.—Negotiations that may soon end in the merging of the Edison Electric Light Company into the Newago Improvement Company are now going forward.

SARATOGA SPRINGS, N. Y.—The Warren County Electric Light and Power Company has filed articles of incorporation and proposes to operate extensively in Saratoga County.

WICHITA, KAN.—At a recent meeting of the directors of the Wichita Railroad and Light Company, it was decided to build a new car barn, purchase new cars, and make other improvements.

BINGHAMTON, N. Y.—The Binghamton Light, Heat and Power Company, recently incorporated at $500,000, will, it is believed, purchase some of the now existing plants and make extensive improvements.

SALEM, MASS.—The Salem Electric Lighting Company is to immediately install new engines and generators at a cost of $100,000 to replace machinery which the increased demands of the business have outgrown.

MANSFIELD, OHIO—The Citizens' Electric Railway, Light and Power Company, of this city, has filed in the Richland County Recorder's office a mortgage for $400,000 in favor of the Cleveland Trust Company.

PORT HURON, MICH.—It is said that the establishment of the proposed Citizens' Electric Light Company's plant in this city is no longer problematical, but that the project is a sure go. The promoters assert that ample capital is back of the enterprise and the plant will be completed within time to allow of the concern's bidding for the next municipal lighting contract to be let in 1903.

ELECTRIC RAILWAYS

EL PASO, TEX.—It is stated that a new line to compete with the existing properties will soon be organized.

MEADVILLE, PA.—The Crawford County Street Railway Company has been granted an extension until November 1, 1902.

CHATTANOOGA, TENN.—The Chattanooga Electric Railway has decided to begin an immediate extension of its lines to Rossville.

ROCKFORD, ILL.—The Rockford & Belvidere Railroad Company contemplates considerable improvements during the coming summer.

DANVILLE, ILL.—A franchise has been accepted for the building of an electric road from Covington to Danville, a distance of fourteen miles.

OSSINING, N. Y.—The Westchester Traction Company has taken possession of the Ossining Electric Railway and an extension to Pleasantville is contemplated.

TERRE HAUTE, IND.—A company, made up of Indiana and eastern capitalists, has started the survey of a road between La Fayette and Terre Haute which will represent an investment of $300,000.

ALBION, N. Y.—The chief engineer of the proposed Ridge road trolley line has just completed a trip over the route that the line is to follow. As soon as the survey is completed, work will be begun.

STAMFORD, CT.—By a vote to construct a bridge over the Miami River the people of Stamford have removed the last obstacle and the Greenwich Tramway Company will construct a line from Greenwich to Stamford.

JONESBORO, TENN.—The county court, in session last week, granted a franchise to a company to build an electric line from this place to Johnson City, work to commence on the line within one year from date of franchise.

CLEVELAND, OHIO—At the annual meeting held recently, the Cleveland Electric Railway Company, known locally as the Big Consolidated System, Henry A. Everett, of the Everett-Moore Syndicate, was reelected president.

KITTANNING, PA.—The survey of the electric road connecting Meredith, Rural Valley, Yatesboro and Kittanning, has been completed and the company is about to let the contract for grading the road-bed and laying the tracks.

PITTSBURGH, PA.—The Elizabeth & Monongahela Street Railway Company has been chartered to build and maintain a line between the borough of Elizabeth, this county, and the borough of Monongahela, Washington County.

DAYTON, OHIO—The Dayton, Springfield & Urbana Electric Railway Company, at the annual meeting of the stockholders, decided to double track the line from this city to Dayton in accordance with the plan to operate through cars from Columbus to Cincinnati. The company will extend the Urbana division to Bellefontaine this spring, and eventually on up to Kenton.

INDIANAPOLIS, IND.—The La Porte & Michigan City Railway Company filed amended articles of incorporation with the Secretary of State. The name is changed to Chicago & Shore Railway Company, and the scope of the corporation enlarged.

PITTSBURGH, PA.—The Homestead & Mifflin Street Railway Company has awarded a contract for building its line at a cost of about $125,000. The line runs over the principal streets of Homestead and has two branches, one to Whittaker and the other to Lincoln Place.

MACON, GA.—Mayor Smith has been authorized to sign a contract with the North and South Macon Street Car Company, allowing it the privilege of operating street car lines along some of the principal streets of Macon. The work must be completed within twelve months.

PATERSON, N. J.—In a conflagration which swept a large portion of the city, the properties of the trolley, telephone, telegraph and electric light companies were destroyed. The fire, it is understood, started in the car barns of the Jersey City, Hoboken & Paterson Street Railway Company.

FORT WAYNE, IND.—R. E. Breed, G. A. H. Shideler, of Marion, and Charles S. King, of Wabash, are at the head of a new company that proposes to build an electric line between Marion and Wabash that will be a connecting link in an interurban system between Fort Wayne and Indianapolis.

PASSAIC, N. J.—A survey is being made and a project is under way to bring this city, Paterson, Clifton, Athenia and Allwood in closer connection with Brookdale, Bloomfield, Montclair and incidentally Newark. This would be done by extending the present Passaic and Orange Valley trolley company's line.

PITTSFIELD, MASS.—Residents of this city, Westfield and Springfield will incorporate the Western Massachusetts Street Railway Company, to operate a street railway from Westfield to Lee, across Hampden, Hampshire and Berkshire counties. The length of the road will be forty miles, and the capital stock is to be $300,000.

SHARON, PA.—A trolley line between Erie and Pittsburgh is proposed by Detroit and Pittsburgh capitalists. Engineer John G. McClymonds has been employed to make a preliminary survey and has already surveyed a line between Franklin and Cambridge. This branch will be built next spring and connect with the line already in operation from that town to Erie.

ST. LOUIS, MO.—The St. Louis, Hillsboro & Southern Railway Company has filed a petition for a franchise in the county court at Clayton for a road to run south through St. Louis County, Jefferson County, "and other counties in this state," without fixing a definite terminus. Thomas F. Sneed, formerly with the St. Louis & Suburban Railroad, is president of the company.

TELEPHONE AND TELEGRAPH

FORT WORTH, TEX.—Application has been made for a charter for the Texas Telephone Supply Company, with headquarters in Fort Worth.

CENTRALIA, N. Y.—Arrangements are now nearly completed for a telephone line connecting Sinclairville, South Stockton and Centralia.

LAKE MILLS, WIS.—The Interurban Telephone Company, Madison, has purchased the Lake Mills Telephone Company, and is planning many extensions.

OSHKOSH, WIS.—The Wisconsin Telephone Company intends spending $90,000 during the year, $70,000 of which will be used for putting the system underground.

JAMAICA, L. I.—The Seaboard Telegraph Company has received a permit to repair its telephone lines. The company intends great extensions in the immediate future.

CLAREMORE, I. T.—The Indianola Telephone Company, of Tulsa, is securing the right of way preparatory to constructing a long-distance line from Claremore to Sapulpa.

ALBANY, N. Y.—The Co-Asperant Telephone Company, of Whitehall, has filed with the Secretary of State a certificate of increase of capital from $15,000 to $50,000.

TRENTON, N. J.—The plant and franchise of the Home Telephone Company, of Trenton, have been sold at auction under foreclosure proceedings for the sum of $20,000.

MARIETTA, OHIO—The Home Telephone Company, Corlville, Ohio, has been reorganized, and among other improvements and extensions purposes building a line to this city.

JANESVILLE, WIS.—At a recent meeting of the Badger State Long-Distance Telephone Company a reorganization was effected, the indebtedness of $33,000 cleared up, and the head office of the company changed from Milwaukee to Janesville.

JOPLIN, MO.—The independent telephone companies of Joplin, Carthage, Webb City and Carterville, Mo., have been merged into one concern. The new company will establish headquarters at Joplin, and will immediately expend a large sum in improvement of the service.

ALBANY, N. Y.—The Home Standard Telephone Company will erect a fine new exchange building. The new structure will cover a ground space of seventy-eight feet by sixty feet. Every modern convenience will be supplied for the accommodation of the patrons, officials and employés. The building will be practically fireproof.

CHICAGO, ILL.—On April 9 or 10, during the convention of the Illinois Independent Telephone Association, a banquet will be tendered to visiting exchange representatives by the telephone manufacturers and supply men of Illinois and adjoining states. Complete information will be found in the invitation which will be mailed direct to delegates and representatives.

ELECTRICAL SECURITIES

The market appears to be strong and the recent beneficent financial developments have been reflected in the past week's stock market by improved speculative and investment interest and activity, the consequence being a broader, upward tendency.

As many similar combinations are planned, some of them having already been well advanced, on the lines of the Northern Securities Company, and are being held in abeyance until the pending legal question is decided, the importance, marketwise, of that outcome is made evident. As nothing will be done in these plans for the next fortnight, they can be dismissed from the immediate market outlook.

ELECTRICAL SECURITIES FOR WEEK ENDING FEBRUARY 8.

New York:	Closing.
Brooklyn R. T.	66⅞
Con. Gas	218
Gen. Elec	290¾
Man. El	133⅞
Met. St. Ry	173¼
Kings Co. Elec	187
N. Y. & N. J. Tel. Co	167½
Telep., Tel. & Cbl. Co	5

There has been no official statement in regard to the Metropolitan plan of financing, but the plan has been informally given with substantial accuracy. The Manhattan Securities Company, with a cash capital of $30,000,000 is to lease Metropolitan and guarantee a dividend of 7 per cent, provisions being made also for the acquisition by the company of some of the Metropolitan interests as a basis for financiering.

General Electric's strength was a feature of the closing market. It is said that this company's saving by the 6-cent cut in copper was equivalent to 7¼ per cent on the stock. The company is reported to have filled its needs at 11 cents.

Boston:	Closing.
Am. Telep. & Tel	159
Edison Elec	260
Erie Tel	21
New Eng. Tel	140
Mass. Elec. pf	94¼
Westing. Mfg. pf	87½
Western Telephone & Telegraph	95

It is understood that it is not the intention of the American Telephone and Telegraph Company to ask Mr. John I. Sabin to accept the presidency of the Erie Telephone and Telegraph Company, but that President Cutler of the New York Company will probably be offered the position.

Philadelphia:	Closing.
Elec. Co. of America	6¼
Philadelphia Elec	4⅜
Union Traction	37⅜
United G. I. Co	124
Elec. Stor. Bat. c	63
Elec. Stor. Bat. pf	65

At the recent special meeting of the directors of the United G. I. Company, it was resolved to increase the stock from $22,500,000 to $28,250,000. The strength of Union Traction and United Gas has helped the whole local market. Philadelphia Electric and Electric Storage Battery stocks and bonds are in better request.

Chicago:	Closing.
Central Union Tel	40
Chicago Edison Light	164
Chicago Telep	185
Metropolitan El. pf	89⅝
National Carbon	22¾
National Carbon pf	84
Union Traction	11½
Union Traction pf	47½

It is reported that the common stock of the National Carbon Company will be placed on a 4 per cent dividend basis at the annual meeting February 24. The report is current in both New York and Chicago, and the action of the stock in the market for the last few days lends color to it. Metropolitan Elevated issues sold off sharply at closing, on account of the reduction of the dividend on the preferred stock.

NEW INCORPORATIONS

CAMDEN, N. J.—The Shaw Electrical Company. $15,000.

GUYSVILLE, OHIO—The Guysville Telephone Company. $3,000.

PORTLAND, ORE.—The Oregon General Electric Company. $2,000,000.

NACOGDOCHES, TEX.—Nacogdoches Light and Power Company. $20,000.

CHASE, ATHENS CO., OHIO—The Irwin Valley Telephone Company. $300.

CHICAGO, ILL.—Continental Telephone Company. The number of directors increased from three to five.

PHILLIPSBURG, N. J.—The Warren Telephone Company. $100,000. Incorporators: M. T. Lynch, John H. McGrath and others.

WILMINGTON, DEL.—Hadel Light Company, of Wilmington, to engage in private and public lighting by gas, electricity and otherwise.

WAUKON, IOWA—The Standard Telephone Company has filed an amendment to its charter increasing its capital stock from $100,000 to $200,000.

CAMPBELL, ILL.—Farmington Citizens' Mutual Telephone Company. $2,500. Incorporators: W. H. Smith, J. S. Armstrong and J. R. Grismore.

INDIANAPOLIS, IND.—The Alamo Cooperative Telephone Company. $1,000. To operate a telephone system in Montgomery, Fountain and Parke counties.

ST. LOUIS, MO.—Electrical Construction and Maintenance Company. $20,000, which has been paid. Stockholders: V. S. Penoyer, W. H. McLaran and G. D. Harris.

CAMDEN, N. J.—The B. F. Lee Company. $125,000. To construct and operate electric railways, etc. Incorporators: W. L. Clark, Joseph F. Baker, J. A. Odell and others.

JEFFERSON CITY, MO.—The Sarcoxie Electric Light and Milling Company, of Sarcoxie. Capital, $7,500; all paid. Incorporators: B. Pile, Henry Sabert, Levi Smith and others.

PRINCETON, IND.—The Princeton Telephone Company. $25,000. To operate a telephone system at Princeton. Directors: J. W. Ewing, Charles F. Stevens, S. F. Gilmore and others.

SEATTLE, I. T.—The Alaska & Pacific States Telephone Company. $1,000,000. Incorporators: W. H. Parry, A. L. Kasson, F. A. Wing, S. B. Hicks and C. O'Brien Reddin.

BIRMINGHAM, ALA.—Warrior River Power Company. $500,000. Incorporators: J. H. Adams, Robert R. Zell, F. I. Monk and John L. Burns, of Birmingham, and A. L. Zell, of Ensley.

MILWAUKEE, WIS.—The Western Lighting and Electric Company. $25,000. To engage in electric and gas lighting, telegraph and telephone service and electric heating in Milwaukee. Incorporators: J. C. Coogan, C. N. Forrestal and William H. McCoy.

ALBANY, N. Y.—The Universal Telegraph Company. $10,000. To transmit messages from Albany to New York and intermediate points. Stockholders: Albert Klein, of New York city; C. T. Coyne, William Long, George Wilkinson and others, of Albany.

MEMPHIS, TENN.—The Memphis Telephone Company has increased its capital stock from $200,000 to $600,000. This amendment to its charter was filed by the following directors: Harvey Myers, A. B. Thrasher, T. J. Hunt, Frank C. Smith and others.

ALBERT LEA, MINN.—The Albert Lea Light and Power Company. $400,000. To build an electric line across the country from Albert Lea to Mankato. Incorporators: G. C. Edwards, Bridgeport, Ct.; F. N. Jewett, Chicago; R. J. Stockey, M. M. Jones and S. S. Edwards, of Albert Lea.

ST. LOUIS, MO.—The St. Louis, Hillsboro & Southern Railroad Company. $1,000,000. The road will be operated by electric power and will extend from Hillsboro, in Jefferson County, Mo., to St. Louis. Directors: T. F. Sneed, H. D. Brandt, H. W. Huthsing, of St. Louis; Otto Fahenhorst and Edward Weiss, of New York.

CHICAGO, ILL.—Osceola & Neponset Telephone Company, Neponset; $10,000; incorporators: F. W. Bates, Charles Lewis and E. B. Hill. Kempton Telephone Company, Kempton; incorporators: Carl Shulz, John Bergan and J. T. Corkill. Cerro Gordo Telephone Company, Cerro Gordo; $15,000; incorporators: Melvin Welty, A. C. Doyle and Osvar Yarnell.

GEORGETOWN, OHIO—The Ripley, Georgetown, Hillsboro & Columbus Railway. $10,000, in shares of $100 each. To construct and operate an electric way from Ripley to Columbus, passing through the counties of Brown, Highland, Fayette, Pickaway, Madison and Franklin, and touching Georgetown, Sardinia and Hillsboro. Incorporators: W. J. Marshall, O. E. Bare, J. R. Moore and others.

BINGHAMTON, N. Y.—The Binghamton Light, Heat and Power Company. $500,000. To furnish electricity in Binghamton, Lestershire, Port Dickinson, Union and other places in Broome County. Directors: Frank Cunningham, T. M. R. Meikleham, T. J. Waters, of New York city; William B. Dinsmore, of Tuxedo Park; George W. Dunn, Clarence F. Hotchkiss, F. W. Jenkins, George F. Johnson, of Binghamton, and Chauncey Eldredge, of Boston, Mass.

INDUSTRIAL ITEMS

THE AMERICAN TRANSFORMER COMPANY, Newark, N. J., manufactures the American transformer. A catalogue describing and illustrating a considerable line of apparatus will be sent upon request.

EUGENE MUNSELL & COMPANY, New York city, manufacture micanite insulators. This is claimed to be of great advantage in all forms of work, and has become practically standard since its introduction.

THE CUTLER-HAMMER MANUFACTURING COMPANY, Milwaukee, Wis., is sending out additional price lists relative to its motor-starting apparatus. These lists are to be inserted in the present catalogues of the company.

THE BUCKEYE ELECTRIC COMPANY, Cleveland, Ohio, manufacturer of incandescent lamps, reports a very prosperous business on its new type lamp. Mr. Bailey Whipple, of the sales department, is devoting every attention to a larger trade.

THE ELECTRIC APPLIANCE COMPANY, Chicago, Ill., is having a good demand in its telephone department for the No. 36 cabinet-type bridging telephone. This telephone, especially equipped with five-magnet generator, is the one it is pushing for rural line work.

THE FOSTORIA INCANDESCENT LAMP COMPANY, Cleveland, Ohio, reports a large increase of business. Mr. William Rothschild, of this company, has just returned from an extended southern trip and reports the business in that locality to be on a very flourishing basis.

THE ALLIS-CHALMERS COMPANY, Chicago, Ill., is sending out the fifth edition of catalogue No. 46. This contains full descriptive matter and much mechanical formulæ. It relates entirely to the Riedler compressors and blowing engines handled by this company. The book is handsomely bound in a gray cover and presents a decidedly neat appearance.

THE WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY, Pittsburgh, Pa., announces that the Cataract Power and Conduit Company, of Niagara Falls, has recently awarded to it a contract for seven 2,500-horse-power, oil, insulated, water-cooled transformers. These transformers will be wound for 2,200 volts two-phase, to 11,000 or 22,000 volts three-phase, and will duplicate the present equipment in the transformer house at Niagara Falls.

THE WESTERN ELECTRICAL SUPPLY COMPANY, St. Louis, Mo., reports that it is meeting with unusual success with its Browning type of Milwaukee small dynamos and motors. They are entirely new, and embody all the latest and most up-to-date ideas, and are adopted for any and all purposes where any electrical dynamos or motors could be used. The company has issued a very attractive bulletin describing this apparatus fully, which is mailed on application.

THE SPRAGUE ELECTRIC COMPANY, New York city, has closed an order with the Atlas Portland Cement Company for three 400-kilowatt, engine-type, split-pole generators at speed of 156 revolutions per minute for its plant in Hannibal, Mo.; another order is from the De Laval Steam Turbine Company for ten 20-kilowatt and ten 75-kilowatt turbine generators. The Pennsylvania Steel Company has ordered for its new bridge shop at Steelton, Pa., fifteen wall crane trolley hoists, the electric hoisting equipment of which is built by the Sprague company.

THE BAIRD MANUFACTURING COMPANY, Chicago, Ill., has perfected and placed on the market an automatic clock switch which appears to be constructed on sound mechanical principles, and is guaranteed by the company to give satisfaction. By a singular coincident this instrument was about to be placed at the time of the appearance of a note in the editorial columns of this journal that "there is a large demand for a simple, cheap and efficient clock-controlled time switch, etc." This company advertises on another page of this issue what it claims is an answer.

THE STILWELL-BIERCE & SMITH-VAILE COMPANY state that it is experiencing a very favorable trade condition. Among the recent contracts have been the following for Stilwell feed-water heaters: Consolidated Light and Power Company, Evansville, Wis., one size E; Arnold Electric Power Company, one No. 4 cast-iron heater; Jacksonville Gas Light and Coke Company, Jacksonville, Fla., one No. 4 cast-iron heater; Duncan Electric Manufacturing Company, La Fayette, Ind., one size D; Vinita Electric Light and Power Company, Vinita, I. T., one size E2; Hamilton Gas Works, Hamilton, Ohio, one No. 4 round heater.

THE SAFETY INSULATED WIRE AND CABLE COMPANY, of New York, is engaged in filling an order for the Mexican Government for 582 miles of deep sea cable. This enterprising American manufactory of wires and cables is also negotiating for another similar order for a southern government amounting to 1,000 miles of deep sea cable. The Safety Company has commenced operations at its new tide water factory at Bergen Point, N. J., and is armoring its cables now at that point and within a short time will move its entire factory there. Mr. Leonard Requa, the head of this company, is a firm believer in the ability of this country to manufacture its own deep sea cables and was one of the first to arrange for facilities for this purpose.

THE BRYAN-MARSH COMPANY, of 136 Liberty street, New York, points with pride, very properly, to its historic record of twenty years. The company was established under the name of the Schaeffer Electric Company, at Cambridge, Mass., as makers of incandescent lamps. The plant was removed to Marlboro in 1891 and incorporated as the Germania Electric Company with added capital. In 1894 the entire business was purchased outright by the Bryan-Marsh Company, the most modern machinery installed and the entire interest devoted to the manufacture of incandescent lamps. At the present time the factory has a total capacity of over 20,000 lamps per day, and under the energetic management of Mr. Converse D. Marsh, the head of the company, has won an enviable reputation for excellence and reliability of product.

PERSONAL MENTION

DR. LOUIS DUNCAN, the well-known electrical engineer, has been quite ill for several months past with pneumonia. Dr. Duncan is at present at Asheville, S. C., and is reported to be rapidly improving, and will probably be able to return to New York in two or three weeks.

MR. THOMAS L. TOWNSEND has severed his connection with the firm of Partrick, Carter & Wilkins, and will be associated with the Vallee Brothers Electrical Company, of Philadelphia, as general manager. His old employers are reluctant to dispense with his services, and join with his numerous friends in wishing him great success in his new field.

COLONEL S. G. BOOKER has resigned as president and severed all connections with the Booker Carbon and Battery Company, of St. Louis, Mo., and states that he does not expect at any future period to engage in the carbon business. Colonel Booker's business career has been a most active and interesting one. For many years he has been identified with the production of carbon and especially carbon products as used in the electrical arts. Colonel Booker has not yet decided as to what new business he will embark.

MR. F. S. TERRY, who is well known in the electrical field as one of the pioneer electrical manufacturers, is devoting his energies to the incandescent lamp industry, and has become one of the ubiquitous men of that field. Mr. Terry has offices in three cities, New York, Cleveland, and St. Louis, and divides his time fairly well between them with a slight leaning for New York city. His "Sunbeam" incandescent lamp is one of the well-known and successful incandescent lamps of the day.

MR. H. DURANT CHEEVER, of the Okonite Company, New York, is possessed of a very interesting telephone scrap book of 1877, formerly the property of his brother, the late Commodore Charles A Cheever. Commodore Cheever and his associate, Mr. Willard L. Candee, were the pioneers in the installation of the telephone in New York city. Clippings from the press of the year 1877, commenting on the telephone and its uses, are of particular interest at this date, especially some of those in which prophecies concerning the future of the telephone are made and illustrations of the apparatus of that period are given.

OBITUARY NOTICE

MR. DANIEL W. BAKER, JR., of the Baker & Company platinum refining works, Newark, N. J., died on Saturday, February 8. While crossing the street Mr. Baker slipped and fell beneath the wheels of a heavy trolley car which passed over him. Mr. Baker was forty years old, and resided in Newark. News of his death will be a shock to a host of friends, many of whom are prominent in electrical circles. Mr. Baker was a brother of Mr. C. O. Baker, Jr., who is well known in the electrical field.